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Field Trip Guidebook to the Hemlo Area

By
G.C. Patterson

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FOREWORD

During the year 1983, exploration activity increased dramatically in the North Central Region; the number of days of assessment work filed was roughly equal to what has been filed in the last 10 years. Much of the increased exploration activity can be attributed to the Hemlo discovery and the economics of gold. Normally, a major discovery such as the Hemlo find results in a staking rush which engulfs the "greenstone" belt in which the deposit is located. However, the Hemlo rush represents more than just "on strike" staking. Rather, it represents the arrival, or at least the application, of new geological concepts to gold exploration. This has wide ranging consequences for exploration in Archean terrains. In essence, the Hemlo discovery has increased the mineral potential of Early Precambrian supracrustal metasediments, estimated to constitute 5 to 10 percent of the Archean "greenstones", and has opened up opportunities for exploration in untested areas.

Numerous requests from mining company personnel to visit the Hemlo area have exceeded the capacity of the Thunder Bay Resident Geologist Office to give tours. This field trip guidebook has been prepared to aid interested parties to familiarize themselves with the regional and deposit geology.

V.G. Milne
Director
Ontario Geological Survey

Conversion Factors for Measurements in Ontario Geological Survey Publications

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0 039 37	inches	1 inch	**25.4**	mm
1 cm	0 393 70	inches	1 inch	**2.54**	cm
1 m	3 280 84	feet	1 foot	**0.304 8**	m
1 m	0 049 709 7	chains	1 chain	20 116 8	m
1 km	0 621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0 155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10 763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0 386 10	square miles	1 square mile	2 589 988	km^2
1 ha	2 471 054	acres	1 acre	0 404 685 6	ha
			VOLUME		
1 cm^3	0 061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35 314 7	cubic feet	1 cubic foot	0 028 316 85	m^3
1 m^3	1 308 0	cubic yards	1 cubic yard	0 764 555	m^3
			CAPACITY		
1 L	1 759 755	pints	1 pint	0 568 261	L
1 L	0 879 877	quarts	1 quart	1 136 522	L
1 L	0 219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0 035 273 96	ounces (avdp)	1 ounce (avdp)	28 349 523	g
1 g	0 032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2 204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0 001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1 102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0 000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0 984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0 029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34 285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1 714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE—Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in cooperation with the Coal Association of Canada.

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Field Trip Guidebook to the Hemlo Area

G.C. Patterson[1]

Introduction

The Hemlo deposit is located 35 km east of Marathon, adjacent to the Trans-Canada Highway 17, and 4 km west of the turnoff to Manitouwadge (Highway 614, *see* Figure 1). Three properties, covering portions of a single large deposit, are under development: the International Corona Resources Limited property (optioned to Teck Corporation), the Williams property (optioned to Lac Minerals Limited), and the Goliath-Golden Sceptre Joint Venture property (optioned to Noranda Mines Limited). Noranda Mines Limited is sinking a 5-compartment shaft to 1435 m and is constructing a 1000 tonnes-per-day mill that will be expanded to 3000 tonnes per day in 1987 (Noranda Exploration Company Limited 1983). Teck Corporation is currently sinking a shaft to 1162.5 m and is constructing a 1000 tons-per-day mill (R. Quartermain, project geologist, Teck Corporation, personal communication 1984). Lac Minerals Limited have let contracts for feasibility studies with initial plans for a 4000 to 6000 tons-per-day mill (Times News, Thunder Bay; December 14 1983).

In addition to the development of 3 mines, approximately 100 companies have been carrying out exploration programs in the area.

Exploration History

Exploration began in the Hemlo area in 1869 near the present town of Heron Bay (Figure 2, Stop 3), where 2 veins were discovered by Moses Pee-Kong-Gay (Patterson 1983a). The veins were shown to A. Cyrette and W. Pritchard in 1872, who reported the occurrence to Captain W. Frue (from Silver Islet). A number of shafts were sunk and some ore was shipped (McKellar 1874); currently, the property is optioned to Lytton Minerals Limited.

In the 1920s J. LeCour, Station Agent at Hemlo, sank a number of test pits on a mineralized shear zone (Bel-Air Resources Limited occurrence; Figure 3, Number 16) just north of Hemlo Station. At about the same time, a series of trenches (currently, on Golden Sceptre Resources Limited property; Figure 3, Number 15) were dug to the north of Mile-Post 38 on the Canadian Pacific Railway mainline by unidentified persons.

The region was first mapped in 1931 by J.E. Thomson of the Ontario Department of Mines. He recommended 2 areas for exploration: Manitouwadge and northeast of Hemlo. Moses Fisher (who had guided J.E. Thomson to Manitouwadge) made a discovery on the western half of the present Lac Minerals Limited property (Figure 3, Number 9). He showed the discovery to a Mr. Ollmann of Heron Bay. A block of 11 claims was staked by J.K. Williams of Maryland, apparently in partnership with Ollmann, in September of 1945. The adjacent ground (Figure 4), now comprising the International Corona Resources Limited property, was staked by T. Page, M. Bartley, Moses Fisher, A. Halliday, and J.K. Williams. Lake Superior Mining Corporation Limited was formed in 1947 to develop the property, with W. Tomas as President. Work, consisting of mapping, trenching, and diamond drilling, was carried out on both the Williams property and the adjoining Lake Superior Mining Corporation Limited property under the direction of T. Page. In 1951, the Lake Superior Mining Corporation Limited property was optioned to Teck-Hughes Gold Mining Limited. They drilled 6000 feet of core which outlined a deposit of 89 000 tons at 0.27 ounce gold per ton (Canadian Mines Handbook) on the present Corona West Ore Zone (Figure 3, Number 1). Further drilling was undertaken in 1957 and 1959; however, the company was dissolved in February 1965.

Subsequently, the (International Corona Resources Limited) property was staked for short periods of time by 4 individual prospectors. No exploration work was filed for assessment credits. In April of 1973, Ardel Explorations Limited staked the property. They completed a further 3 holes and revised the tonnage of the Corona West Ore Zone to 150 000 tons at 0.21 ounce gold per ton (The Northern Miner, February 14 1974). The company charter of Ardel Exploration Limited was cancelled and the property was restaked by R.G. Newman in 1976. These claims were cancelled in January of 1978.

The area remained open until March of 1980, when it was staked by J. Larche in partnership with D. McKinnon. They optioned the property to Mr. Schiralli, who in turn optioned the property to International Corona Resources Limited. At about the same time, Larche and McKinnon staked and optioned the ground adjacent to Goliath Gold Mines Limited and Golden Sceptre Resources Limited (Figure 4). An exploration program under the direction of D. Bell resulted in the discoveries of the East Ore Zone of International Corona Resources Limited (Figure 3, Number 2), optioned to Teck Corporation in November 1981; and the Goliath deposit (Figure 3, Number 5a), optioned to Noranda Mines Limited in November 1982. The Williams claims were optioned to Lac Minerals Limited in 1981, and drilling carried out by the company during the winter of 1982 outlined an economic deposit. Currently, 3 mines are being brought into production.

General Geology

The geology of the area (*see* Figure 2) has been mapped by the Ontario Geological Survey and the former Ontario

[1]Resident Geologist, Ontario Ministry of Natural Resources, Thunder Bay.

Department of Mines (Thomson 1931; Milne 1967, 1968; Muir 1982a, 1982b). This mapping has defined an east-trending belt of Archean metasediments and metavolcanics (part of the Wawa Subprovince) forming a broad synform, with granitic intrusions along its axis. The Quetico Gneiss Belt lies to the north and the Pukaskwa Gneiss Complex to the south. Muir (1982a) divided the belt into 2 main sequences near the town of Heron Bay. The northern Heron Bay Sequence consists predominantly of intermediate to felsic metavolcanics and metasediments. The metavolcanics consist of flows, pyroclastic breccia, and tuff. The coarsest pyroclastic rocks occur near Heron Bay. Towards the east, the pyroclastic rocks gradually become finer grained with a higher component of reworked material (tuffaceous fragments). Near Hemlo, argillaceous metasediments begin to interfinger with the tuffs and tuffaceous metasediments. Further to the east, near Struthers, siltstones predominate. The southern Playter Harbour Sequence consists of mafic pillowed metavolcanics (high-iron tholeiites) which have been intruded by ultramafic sills.

In addition to the main felsic centre at Heron Bay, 4 satellitic felsic centres (or accumulations) consisting of crystal tuffs to pyroclastic breccia were mapped by Bartley and Page (1958). All 4 of these centres occur in the Heron Bay Sequence at or near the contact with the Playter Harbour Sequence, and are located as follows:

1. The Moose Lake centre forms a wedge-shaped body 450 m thick near Botham Lake and tapering to the east of Moose Lake where the pyroclastic rocks interfinger with metasediments. Mapping by Noranda Mines Limited shows the pile is cut off to the west by a fault near Botham Lake. The predominant rock type is a crystal tuff (feldspar-quartz porphyry) with minor units of lapilli-tuff. The Hemlo deposit occurs on the northern contact of the crystal tuff where it interfingers with metasediments east of Moose Lake.

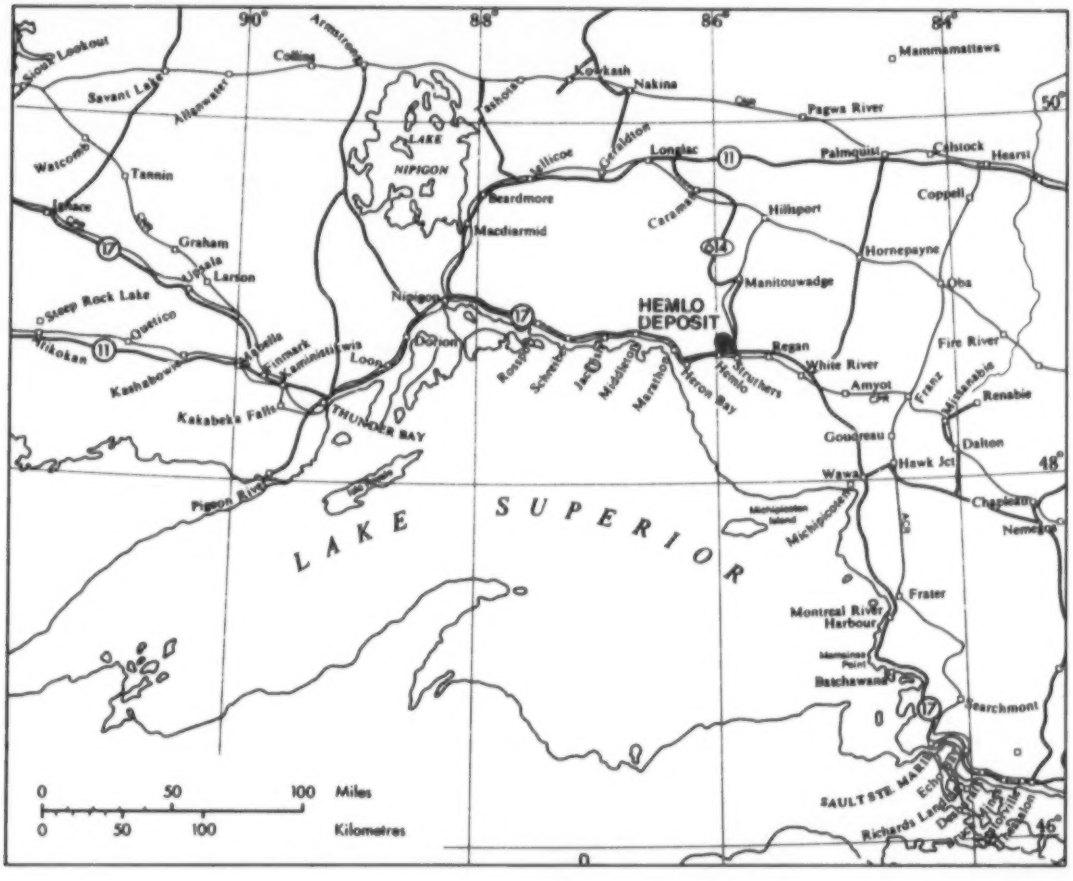


Figure 1. Location map for the Hemlo deposit.

2. The Theresa Lake centre is located in a west-trending pile, 8 km long, at the southern end of Theresa Lake. The felsic pyroclastic rocks are predominately crystal tuffs (quartz-feldspar porphyries) with minor amounts of lapilli-tuff.
3. The White River centre occurs in a west-trending wedge-shaped pile, 3 km south of Rust Lake, and extends east past the White River.
4. The Pic River centre is located 6 km northeast of Marathon. It forms a block of felsic pyroclastic breccias 6 km north-south and 4 km east-west. Pelitic metasediments occur in a unit 1 km wide between the felsic pyroclastic rocks and pillowed mafic metavolcanics to the north and east.

Associated with each of these centres are conglomeratic rocks with clasts derived from local lithologies.

Structural Geology

The large scale structure of the Hemlo Belt can be described as a synform with granitic intrusions (Heron Bay Pluton and Cedar Lake Pluton) occurring along the fold axis. In detail, however, the structure is more complicated (Patterson 1983b). The predominant fabric in the fragmental rocks is the result of a lineation overprinted by a secondary foliation. This lineation appears to show a systematic variation across the southern half of the belt. Near Heron Bay, the plunge of lineation is 45°W; the plunge gradually steepens to the east, being almost vertical near the hamlet of Hemlo, and then 45°E near the town of White River.

Minor folding is common with observed closures on a scale of up to 40 m. Foliation is parallel to the fold plane and the lineation parallels the fold axis. Both the lineation and foliation are folded near Heron Bay. A large scale M-fold with a closure of 5 km can be observed on airphotos. Refolded minor folds (mushroom-shaped interference figures) were observed along the access road into Pukaskwa Park. This suggests a number of phases and orientations of deformation.

Brittle deformation (faulting and shearing) commonly occurs along the contact of brittle and ductile rocks, subparallel to bedding. The Hemlo Fault can be traced from Moose Lake to the hamlet of Struthers (8 km), roughly parallel to the Trans-Canada Highway (17). Near Cigar Lake (*see* Figure 3), the fault is indicated by 1 to 3 m of chloritic schist.

Deposit Stratigraphy

This section represents a summary based on work by R. Quartermain (Teck Corporation), G. Pierce (Noranda Mines Limited), and B. Valliant (Lac Minerals Limited). For detailed information the reader is referred to Quartermain *et al.* (1983), Sheehan and Valliant (1983), and Noranda Staff (1983). During the summer of 1983, outcrops representative of typical units were washed, stripped, and mapped as an adjunct to preparation of this guidebook.

The general trend of the units is 110°, with a dip of 45°N to 55°N; some isoclinal folding is evident. Top indicators show reversals with the majority of the units facing north. The base of the sequence is arbitrarily taken to be the southern contact between a thin unit of mafic metavolcanics and metasediments (Muir 1982b), south of Moose Lake (*see* Figure 5).

The section below describes the highway exposure (*see* Figure 7); distances are across strike and do not represent true thickness:

0 - 75 m: Mafic metavolcanics consisting of massive to strongly deformed and pillowed rocks. The northern contact of the mafic metavolcanics is the Hemlo Fault.

75 - 175 m: Calc-silicate metasediment. Originally a finely bedded marl which has been converted by metamorphism to rock composed of calcium-rich plagioclase and amphibole (tremolite to hornblende).

175 - 180 m: Altered crystal tuff (quartz-sericite schist) composed of quartz crystals 2 to 5 mm in size (up to 10%) in a fine-grained matrix of sericite and quartz, containing minor pyrite and tourmaline. This unit was called the Lake Superior South Zone (Figure 3, Number 12) by Page (1947). At depth, it contains economical gold values (Lower Zone of the Goliath deposit; *see* Figure 13).

180 - 220 m: Metasiltstones with minor calc-silicates containing some magnetite-rich members up to 4 cm wide. This unit serves as a stratigraphic marker due to its magnetic response.

220 - 270 m: Crystal tuff (quartz-eye sericite schists). Locally the unit is bedded, with individual beds defined by the density and size of quartz crystals. The quartz-eyes, up to 3 mm in size, are commonly sheared and deformed (*see* Figure 15).

270 - 290 m: The Ore Zone section is described below under "Property Descriptions". The rocks in this unit are siliceous metasediments, altered tuffs, and fragmental rocks. It was referred to as the "Lake Superior Shear Zone" by Page (1947) (*see* Figure 16).

290 - 390 m: Reworked tuffs with units of pelite and calc-silicate.

390 - 480 m: Pyroclastic rocks consisting of crystal tuffs and associated conglomerates. The upper section of this unit is a crystal tuff with pyrrhotite and pyrite (locally called the "Barren Sulfide Zone" or the "Sucker Zone").

480 - 600 m: Pelitic sediments with units of calc-silicate and siltstone (*see* Figure 17).

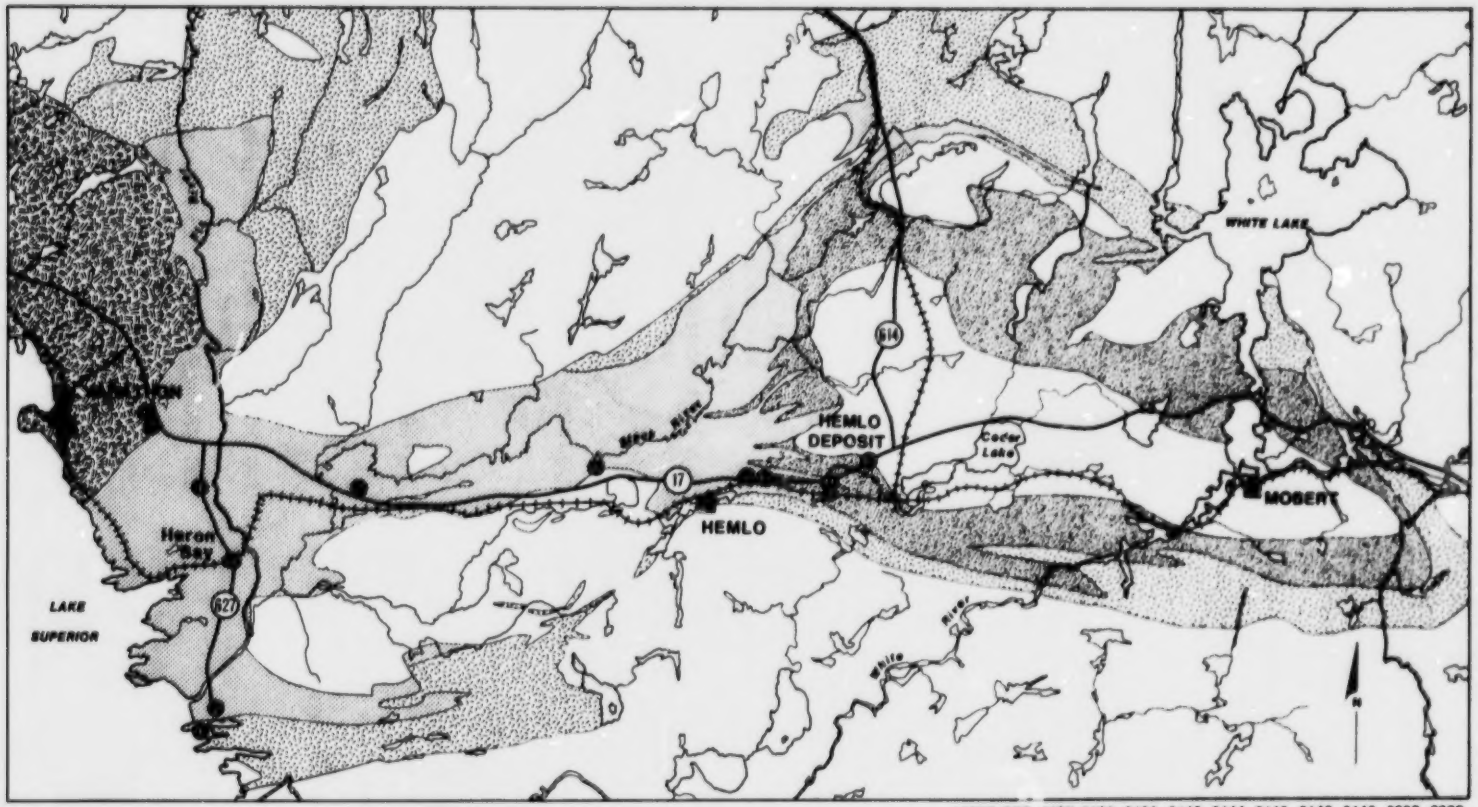


Figure 2. Regional Geology of the Hemlo Area.

600 - 650 m: Crystal tuffs and conglomerates.

650 - 900 m: Calc-silicates and siltstones (locally folds with closures of 40 m have been noted).

All rocks in the section are cut by diabase dikes. Feldspar porphyry and coarse grained feldspar porphyry intrude parallel to foliation.

Size and Grade of the Hemlo Deposit

The combined total of published reserves for the Hemlo deposit is 76 367 679 tons at 0.24 ounce gold per ton. These figures can be broken down as follows:

(1) Noranda Mines Limited (The Globe and Mail, December 20 1983)

Goliath Property:

Upper or Main Zone ..... 19 681 410 tons at 0.29 oz/ton Au

Lower Zone ..... 1 643 089 tons at 0.17 oz/ton Au

Teck Corporation ¼ claim optioned to Noranda Mines Limited (50% Teck Corporation /50% Noranda Mines Limited):

Upper or Main Zone ..... 2 235 704 tons at 0.30 oz/ton Au

Lower Zone ..... 187 476 tons at 0.30 oz/ton Au

Total ..... 23 867 679 tons at 0.28 oz/ton Au

(2) Lac Minerals Limited (The Globe and Mail, December 14 1983)

Zone A ..... 3 850 000 tons at 0.18 oz/ton Au

Zone B ..... 38 150 000 tons at 0.20 oz/ton Au

Total ..... 42 000 000 tons at 0.20 oz/ton Au

(3) Teck Corporation (The Northern Miner, October 13 1983)

East Zone ..... 8 400 000 tons at 0.36 oz/ton Au

Property Descriptions

Goliath Gold Mines Limited

The geology of the Goliath Main Ore Zone (Figure 3, Number 5) has been described by Noranda Mines Limited Staff (1983):

"The Main Ore Zone is composed of a diverse group of strata-bound, pyrite-rich siliceous and locally barite-rich metasediments. They are of probably chemical sedimentary derivation. The mineralized zone ranges from 3 to 40 m and is characterized by sheet-like regularity and by remarkably consistent gold values varying from 4 to 16 grams per tonne. Gold occurs as finely disseminated native gold in the pyritiferous schists. The grade is not dependent on iron sulphide content. The ore-bearing rocks contain appreciable molybdenite. Accessory minerals such as stibnite, realgar, and a light green mica thought to contain titanium, vanadium and/or barium, are characteristic of the deposit. The deposit displays a distinct vertical zoning of layering. Hanging wall sediments grade downward into a molybdenum-rich siliceous schist, then into mixed siliceous, baritic, and locally sericitic schist. Then into a basal lower grade barite-rich horizon."

Further:

"The main ore horizon can be traced laterally along strike into a pyritiferous volcaniclastic unit. This distinctive unit has stretched quartz-feldspar-porphyry fragments and fewer metasediment and cherty clasts, all set in a quartz-feldspar-biotite matrix. It has high background gold values."

"The deposit is underlain by an intensely altered succession of quartz-eye sericite schists with variable amounts of tourmaline, pyrite, rutile and often abundant green mica. A series of feldspar and quartz porphyry sills and dikes intrude both the ore horizon and footwall schists."

Garth Pierce (project geologist, Noranda Mines Limited, personal communication 1983) noted that realgar, orpiment, and cinnabar occur on the margins of late quartz veins, suggesting that these minerals formed late. Longitudinal sections prepared by Noranda Mines Limited show a high grade core containing abundant molybdenite, barite, stibnite, and arsenic minerals. This core trends to the northwest, straddling the western boundary with the Lac Minerals Limited property. A summary of the mineralogy of the deposit is given in Table 1.

A second mineralized horizon, the Lake Superior South Ore Zone or the Goliath Lower Zone (Figure 3, Number 12), has been intersected 30 to 80 m below the Main Ore Zone. Garth Pierce (project geologist, Noranda Mines Limited, personal communication 1983) states that the internal zoning is very similar to the main zone.

International Corona Resources Limited

The geology of the International Corona Resources Limited deposit was summarized by Quartermain *et al.* (1983):

"The mineralization is confined to the contact between felsic volcanics to the south and clastic sedimentary rocks to the north. The two ore zones are enclosed by intermediate-felsic lapilli tuff. This lapilli tuff is structurally and stratigraphically(?) underlain by massive rhyodacite and by quartz-eye felsic crystal tuff, both of which thicken from east to west. The hanging wall consists of siltstone, argillite, conglomerate and minor felsic tuff. Alteration, characterized primarily by the development of white mica in the footwall and in the ore horizon felsic volcanics, appears to be pre-tectonic and hydrothermal, and increases in intensity from east to west."

Further:

"The gold in the East Zone [*Figure 3, Number 2*] occurs as very fine (0.4 mm diameter), discrete grains, is usually associated with fine-grained, disseminated pyrite and molybdenite, and is hosted by laminated silty subgreywacke. In the West Zone

TABLE 1 | THE MINERALOGY OF THE GOLIATH DEPOSIT (FROM UNPUBLISHED NORANDA MINES LIMITED BOOKLET, RESIDENT GEOLOGIST'S FILES, ONTARIO MINISTRY OF NATURAL RESOURCES, THUNDER BAY)

Silicates, Sulphates, Carbonates, Oxides

Quartz - SiO_2: total SiO_2 = 55 percent, 48 to 70 percent range

Barite - $BaSO_4$: 12 percent average, 0 to 40 percent range

Micas - K,Al,Fe,Mg,(V),(Ti),OH, silicates: 5 to 30 percent

Feldspars - K,Na,Ca,Al,(Ba), silicates: 0 to 15 percent

Calcite - $CaCO_3$: 0 to 15 percent

Rutile - TiO_2, and Sphene - $CaO.TiO_2.SiO_2$: 0.3 to 0.4 percent

Chlorite, Amphibole - Fe,Mg,(Al),(Ca),(Na),OH, silicates: moderate to minor

Tourmaline, Diopside, Sillimanite, Garnet, Staurolite, Epidote - silicates: minor

Common Sulphides and Graphite

Pyrite - FeS_2: 8 percent average, 5 to 20 percent range

Molybdenite - MoS_2: 0.16 percent average, 0.03 to 0.40 percent range

Sphalerite - ZnS: Zn = 0.006 percent average, 0.003 to 0.024 percent range

Chalcopyrite - $CuFeS_2$: Cu = 0.002 percent average, 0.001 to 0.004 percent range

Pyrrhotite - FeS_x: traces

Graphite - C: 0.04 percent average, trace - 0.12 percent range

Gold-Bearing Minerals

Native Gold - Au (Ag = 0 to 20 percent): Au = 10 grams/tonne

Aurostibnite - $AuSb_2$: several grams/tonne in part of drill hole HGG-14

Antimony, Arsenic, and Mercury-Bearing Minerals

Stibnite - Sb_2S_3: minor but widespread; Sb = 0.02 percent average, 0.01 to 0.16 percent range

Native Antimony - Sb: traces

Berthierite - $FeSb_2S_4$: traces

Gudmundite - FeSbS: traces

Jamesonite - $FePbSb_2S_6$: traces

Boulangerite - $Pb_5Sb_4S_{11}$: traces

Chalcostibnite - $CuSbS_2$: traces

Tetrahedrite - $(Cu,Fe,Zn,Ag,Hg)_{12}(Sb,As)_4S_{13}$: minor to traces; 0 to 2 percent Ag

Arsenopyrite - FeAsS: trace

Native Arsenic - As: trace

[*Figure 3, Number 1*], the auriferous silty subgreywacke is discontinuous and occurs as lensoid segments separated by lower grade quartz-feldspar-white mica-fuchsite(?)-tourmaline schist. Possible clasts of East Zone-type material occur sporadically in the sedimentary hanging wall."

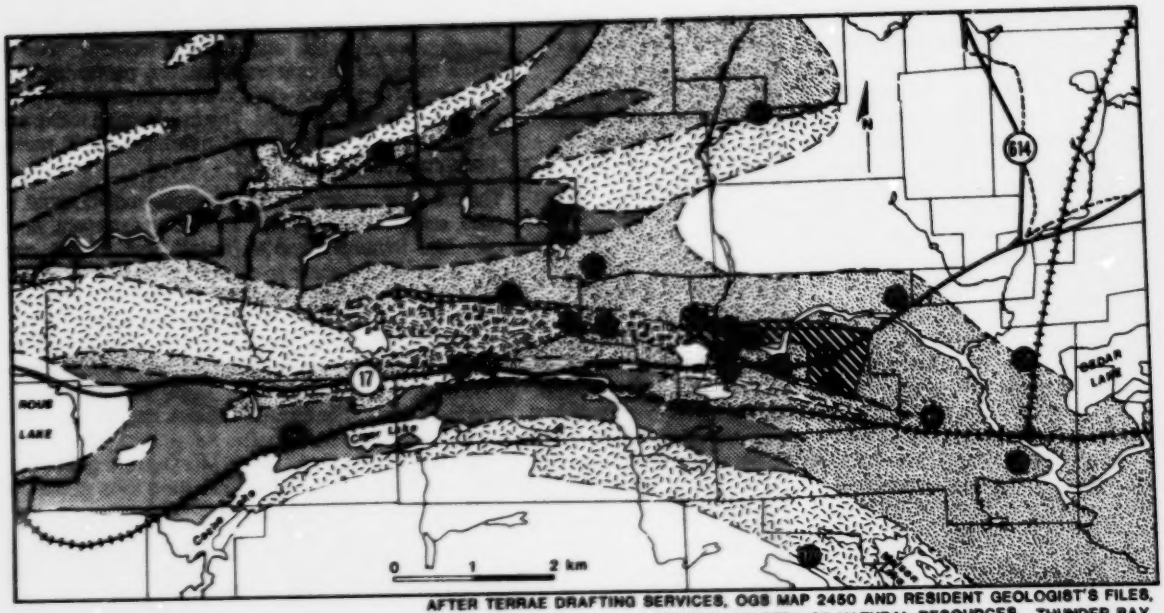
R. Quartermain (project geologist, Teck Corporation, personal communication 1983) has suggested that the presence of clasts of East Zone mineralized siliceous metasediments in the lapilli-tuff unit, supports the concept of an unconformity within the deposit stratigraphy. Minor barite has recently been identified in the East Ore Zone (R. Quartermain, project geologist, Teck Corporation, personal communication 1984).

Lac Minerals Limited

The general geology was described by Sheehan and Valliant (1983):

"The orebody is within a sequence from oldest to youngest of massive and fragmental basalt, massive, parallel and cross-laminated psammitic turbidite, felsic ash and quartz crystal-bearing tuff and another unit of turbidite which becomes progressively finer-grained stratigraphically upward. These rocks strike 110 degrees and dip 60 degrees north and are intruded by feldspar porphyritic felsic plugs and related dykes and sills. All rocks are intruded by late Archean north-trending diabase dykes. The orebody is stratiform at the contact of underlying tourmaline-rich quartz crystal tuff and overlying arsenopyrite-, staurolite-rich turbidite and in places transgresses both rock types. Ore consists of stratified quartz-, muscovite-, pyrite-rich rock and muscovite-, amphibole-, biotite-, pyrite-rich turbidite. Accessory minerals include garnet, staurolite, molybdenite, stibnite, arsenopyrite, magnetite and sphene."

The main Williams deposit (Lac Minerals Zone A, *see* Figure 3, Number 3) has been trenched exposing the ore zone (*see* Figure 14). Alex Matzok (project geologist, Lac Minerals Limited, personal communication 1983) has described the ore zone from the hanging wall (northern contact) to the footwall (southern contact, Figure 13). The hanging wall rocks consist of altered pelitic sediments, and contain arsenopyrite. This is followed by 2 to 3 m of massive pyrite which is low in gold content. Next the up-



AFTER TERRAE DRAFTING SERVICES, OGS MAP 2450 AND RESIDENT GEOLOGIST'S FILES, ONTARIO MINISTRY OF NATURAL RESOURCES, THUNDER BAY

ARCHEAN

- GRANITIC ROCKS
- FELSIC METAVOLCANICS (UNSUBDIVIDED)
- CRYSTAL TUFF (QUARTZ-EYE TUFF)
- MAFIC METAVOLCANICS (MASSIVE TO PILLOWED)
- METASEDIMENTS (SILTSTONES, CALC-SILICATES AND PELITES)
- UP-DIP PROJECTION OF HEMLO DEPOSIT
- OCCURRENCE

OCCURRENCES

1. CORONA WEST ORE ZONE, LAKE SUPERIOR MAIN ZONE
2. CORONA EAST ZONE
3. LAC MINERALS ZONE A (WILLIAMS PROPERTY)
4. LAC MINERALS ZONE B (WILLIAMS PROPERTY)
5a. GOLIATH MAIN ZONE 5b. TECK 1/4 CLAIM
6. GOLIATH EAST ZONE
7. STRUTHERS OCCURRENCE
8. SCEPTRE NORTH ZONE
9. LAC MINERALS WEST ZONE (WILLIAMS PROPERTY)
10. FRACTURE ZONE, SCEPTRE SOUTH ZONE
11. BARREN SULPHIDE ZONE
12. LOWER ZONE, LAKE SUPERIOR SOUTH ZONE
13. INTERLAKE DEVELOPMENT OCCURRENCE
14. MUIR ZONE, HIGHWAY ZONE
15. MILE 38 OCCURRENCE
16. BEL-AIR OCCURRENCE
17. LAKE SUPERIOR NORTH ZONE
18. PISCEMORE OCCURRENCE (LOCATION APPROXIMATE)
19. DAKOTA ENERGY OCCURRENCE
20. LYNX CANADA (LOCATION APPROXIMATE)
21. MoS_2 BEARING VEIN (GOLIATH GOLD MINES LTD)
22. MoS_2 BEARING VEIN (GOLIATH GOLD MINES LTD)
23. MoS_2 BEARING VEIN (CAULFIELD RES LTD LOCATION APPROXIMATE)

Figure 3. Geology of the Hemlo Area.

per siliceous zone (5 m thick) is composed of a gold-bearing siliceous metasediment containing Ba-muscovite, barite, molybdenite, and 2 to 5% pyrite. This is in contact below with a fragmental rock (10 m thick) consisting of 30 to 50% disrupted layers and fragments of siliceous metasediments in a pyritic matrix. Within the fragmental unit are bands of highly deformed sericite schist (altered tuffs) that contain stibnite and cinnabar. The base of the ore zone is another gold-bearing siliceous metasediment similar to the upper siliceous unit. The footwall rock (from drill core) consists of a quartz-eye sericite schist (altered tuffs). All these rocks are cut by fine grained feldspar porphyry sills.

A second deposit was announced by Lac Minerals Limited in The Northern Miner Newspaper (September 15 1983, p.1); few details have been given. The deposit occurs in the western half of the Williams block and appears to be a strike continuation of the "Golden Sceptre Fracture Zone" (*see* "Golden Sceptre Resources Limited" below and Figure 3, Number 9).

Summary of the Main Deposit

The Hemlo deposit (*see* Figure 5) occurs at the contact between crystal tuffs and metasediments, where the crystal tuffs wedge out against the metasediments. The metasediments consist of graded siltstone, pelites, reworked tuffs, and calc-silicates. The crystal tuffs near the deposit are altered, and contain sericite, tourmaline, green mica, barite, and hematite. The pelitic composition of the metasediments may, in part, be derived from alteration of sedimentary rocks. The ore-hosting rocks are sericite schists (altered crystal tuffs), siliceous metasediments, and fragmental rocks.

The ore mineralogy consists of pyrite, molybdenite, native gold, stibnite, arsenopyrite, cinnabar, orpiment, and realgar. The mineralization is zoned both across dip and along strike. The across-dip zonation in the Goliath deposit consists of a molybdenite-rich siliceous schist in the hanging wall, followed by mixed siliceous, baritic, and sericitic schists, to a baritic unit in the footwall. An apparent zonation along strike can be seen when comparing the Goliath deposit and the Williams deposit with the Corona East Zone. The Goliath deposit appears to represent a core rich in Au, Mo, Sb, Ba, As, and Hg with a rim (Corona East Zone) rich in Au and Mo. Current grade and tonnage estimates are 76.4 million short tons at 0.24 ounce gold per ton.

Models of Ore Genesis

Most workers in the area suggest the deposit is penecontemporaneous with volcanism, being a syngenetic or an epithermal deposit. The epithermal model has a number of modifications (*see* Figure 6).

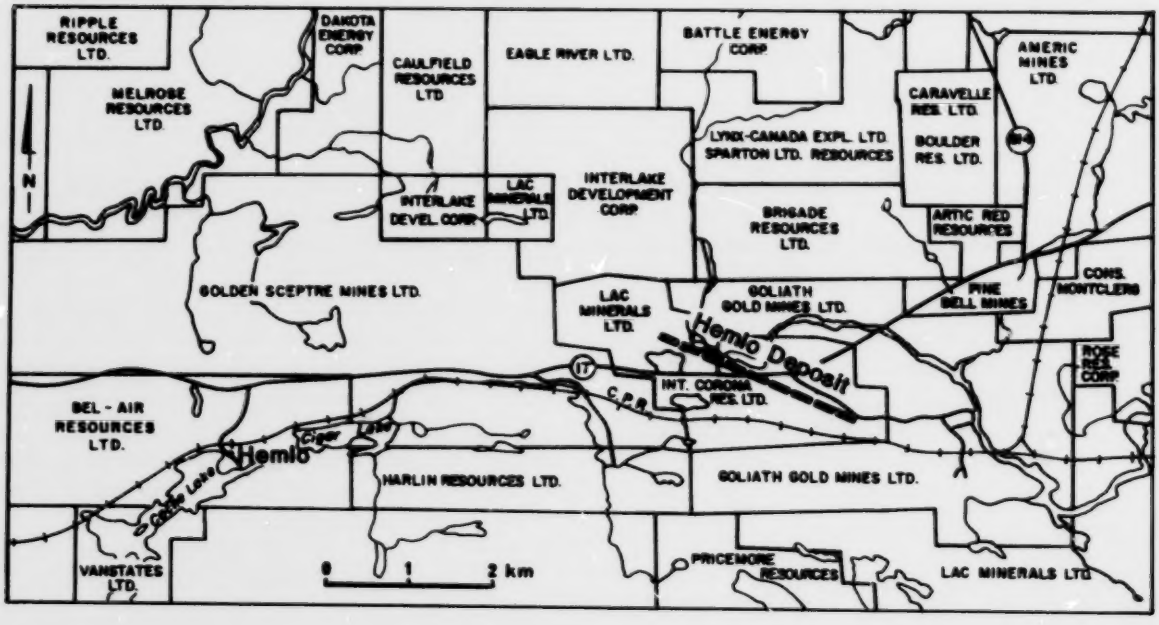
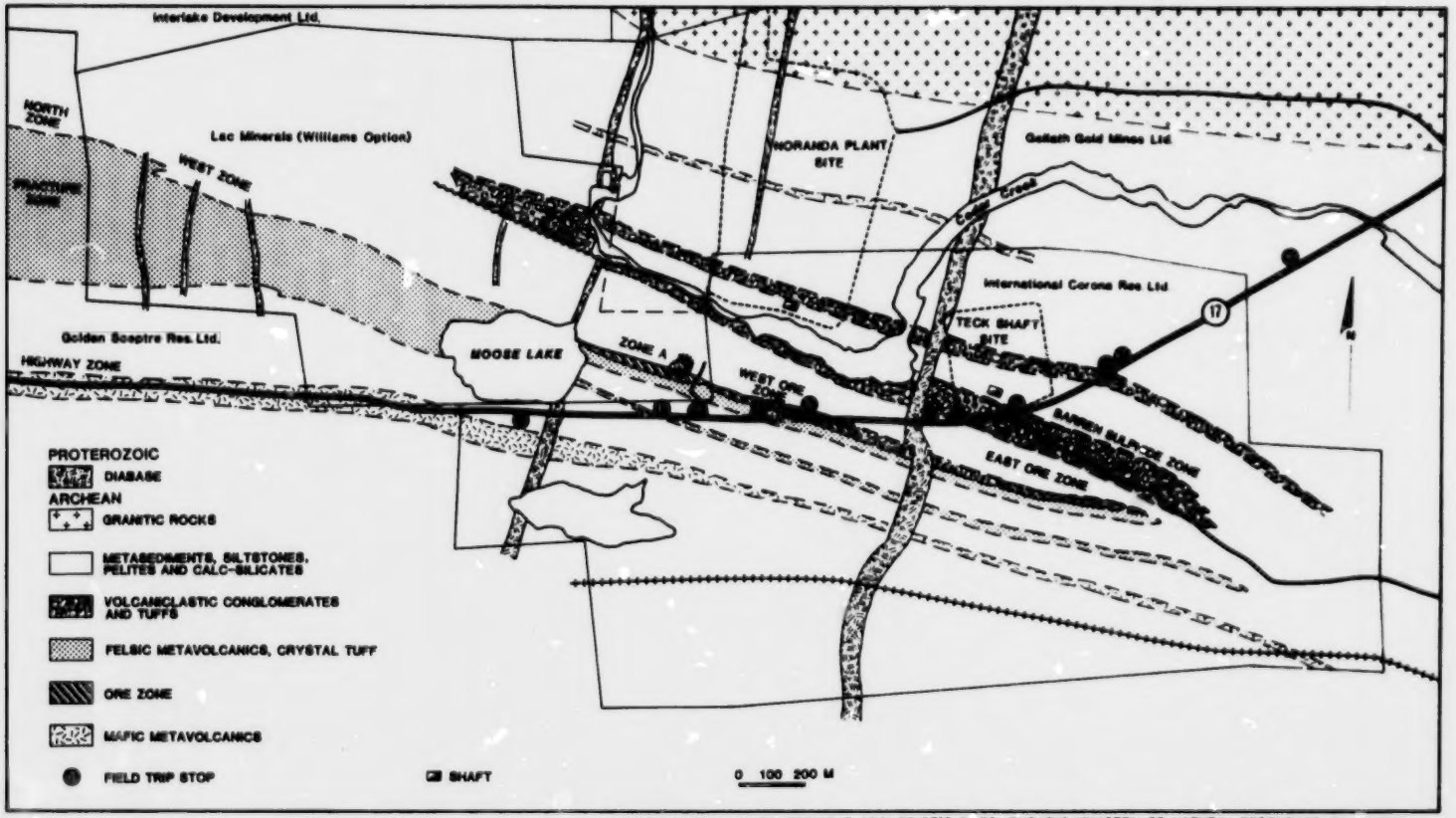


Figure 4. Hemlo property map, January 1984 (after Terrae Drafting Services).



AFTER COMPANY MAPS, RESIDENT GEOLOGIST'S FILES, ONTARIO MINISTRY OF NATURAL RESOURCES, THUNDER BAY

Figure 5. Geology of the Hemlo Deposit—Stop 11.

1. Hot spring solution deposits—a chemical sediment rich in metal deposited at or near a vent. A number of modern equivalents have been described in New Zealand (Weissberg 1969). Both the metal associations (gold, arsenic, antimony, and mercury) and the alteration patterns are similar to Hemlo.

2. Deposition of metal-rich sediments within porous units such as unwelded tuffs, fragmentals, and fault zones—this class can be thought of as the fissure system associated with hot springs. Examples of deposits of this group include those near Goldfield, Nevada, which occur in tuffs (Boyle 1979); and the Getchell deposit or the Gold Acres deposit, Nevada, which are associated with fault zones (Joralemon 1975).

3. Deposition of metal within chemically favourable rocks—the Carlin deposit, Nevada is associated with the replacement of limestones by silica. Similar deposits occur in ultramafic rocks which have undergone carbonatization and later reacted with epithermal solutions (Henderson 1969).

In comparing the Hemlo deposit to epithermal deposits, there are a number of clear similarities. The metal associations at Hemlo and in epithermal deposits are similar—gold, molybdenite, arsenic, antimony, mercury, and barium are major constituents. Alteration in epithermal deposits consists of silicification, and deposition of tourmaline, sericite, potassium feldspar, biotite, and kaolin. Direct comparison of alteration at Hemlo is difficult due to the masking by amphibolite grade metamorphism. However, tourmaline, sericite, microcline, and silicification are present. At Hemlo, kaolin-rich rocks may be represented by pelites. Many of the hot spring systems in New Zealand and Nevada are associated with felsic volcanic rocks and porphyry dikes, both of which are present at Hemlo.

It is not clear which of the modifications on the epithermal model is most applicable or if more than one mechanism was operative. The occurrence of clasts of ore-bearing sediments in fragmental rocks tends to support the assumption that primary metal-rich sediments were formed. However, a large part of the orebody occurs in fragmental rocks or tuffs which would have had a high initial porosity. As well, there are abundant carbonate rocks overlying the ore zone that could have acted as a concentrating chemical trap for gold. It is also notable that the Goliath deposit contains an average of 0.04% graphite (Table 1).

In this discussion, the role of deformation should not be overlooked. The mineralized horizon occurs at the contact between a brittle unit and a ductile unit. Thus deformation, focused on this horizon, could have generated porosity which acted as a conduit and structural trap for mineralizing solutions. The role of deformation in the origin or modification of the deposit has not been empirically determined.

The application of the epithermal model has obvious implications in other gold exploration areas such as Timmins and Red Lake where carbonates generated by the alteration of volcanic rocks or ultramafic rocks may have formed a chemical trap for epithermal solutions.

Gold Occurrences in the Hemlo Area

The reader is referred to Figure 3 and Figure 8 for the relationship between the main Hemlo deposit and the occurrences described below.

Golden Sceptre Resources Limited

The property extends as a band 3.2 km wide by 9.7 km long to the west of the property of International Corona Resources Limited. The property was optioned to Noranda Exploration Company in November 1982. Three mineralized zones have been discovered during an exploration program which included geological mapping, trenching, an Induced Polarization survey, and soil geochemistry. One of the zones, the Golden Sceptre Fracture Zone (*see* Figure 3, Number 10) is located 800 m north of Highway 17, with its eastern boundary adjoining the Lac Minerals Limited property. The Fracture Zone is "hosted" in quartz veins which cut a quartz-eye tuff. This zone appears to be a strike extension of mineralization discovered during the 1950s on the western side of the Lac Minerals Limited property (Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay). The mineralization consists of native gold, molybdenite, pyrite, and telluride minerals. Initial diamond drilling has intersected a number of high grade zones (up to 3.36 ounces gold per ton) over narrow widths (1.6 to 4.9 feet; George Cross Newsletter, Number 204; October 25 1982). An eastern strike extension of the mineralization to Lac Minerals Limited Williams property (Figure 3, Number 9), appears to be the deposit announced in The Northern Miner Newspaper (September 15 1983, p.1).

The second zone is located 150 m north of the first zone (Figure 3, Number 8). It is defined by an east-trending soil geochemical anomaly. Assays of diamond drill core are as follows: Hole 4 - 21 feet of 0.33 ounce gold per ton; and Hole 19 - 36 feet of 0.325 ounce gold per ton (The Northern Miner, November 18 1982).

Drilling carried out during 1983 extended the zone 2.4 km further west (Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) to Botham Lake. Although no assays were reported, references to green mica, molybdenite, stibnite, and pyrite were made.

The third zone, the Highway Zone (Figure 3, Number 14 and Figure 7), was sampled by Muir (1982b) and assayed at 0.32 ounce gold per ton. Mineralization consists of pyrite, native gold, and minor molybdenite, and is hosted in volcaniclastic metasediments. The unit is up to 2 m wide and can be traced from Moose Lake to Cigar Lake (also known as "Finger Lake"), a distance of 3 km. The volcaniclastic metasediment consists of 50% frag-

ments of feldspar porphyry, chert, and altered volcanic rocks, 2 mm to 5 cm in size, which have been stretched up to 15:1 parallel to foliation. The matrix contains sericite, green mica, and tourmaline.

Goliath Gold Mines Limited

The property surrounds the International Corona Resources Limited property on 3 sides (east, north, and south).

To the east, 100 m south of Struthers, mapping has indicated the presence of molybdenite and pyrite in a sericite schist (Figure 3, Number 7) on strike with the "Corona East Ore Zone". Recent diamond drilling by Noranda Mines Limited has intersected sericite schist containing molybdenite and stibnite (Figure 3, Number 6); no assays have been reported (Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

A number of quartz veins containing minor molybdenite occur on Highway 17 to the east of the Noranda access road (Figure 3, Number 22), and on the Manitouwadge Railway spur 1.5 km south of Highway 17 (Figure 3, Number 21). Quartz veins up to 10 cm wide cut metasediments near the contact with the Cedar Lake Pluton. A number of similar occurrences have been reported on other properties in the area.

Heron Bay Gold Mine and Bowhill Mines Occurrence

Lytton Minerals Limited have optioned the Heron Bay Gold Mine and Bowhill Mines occurrence from V. Sten-

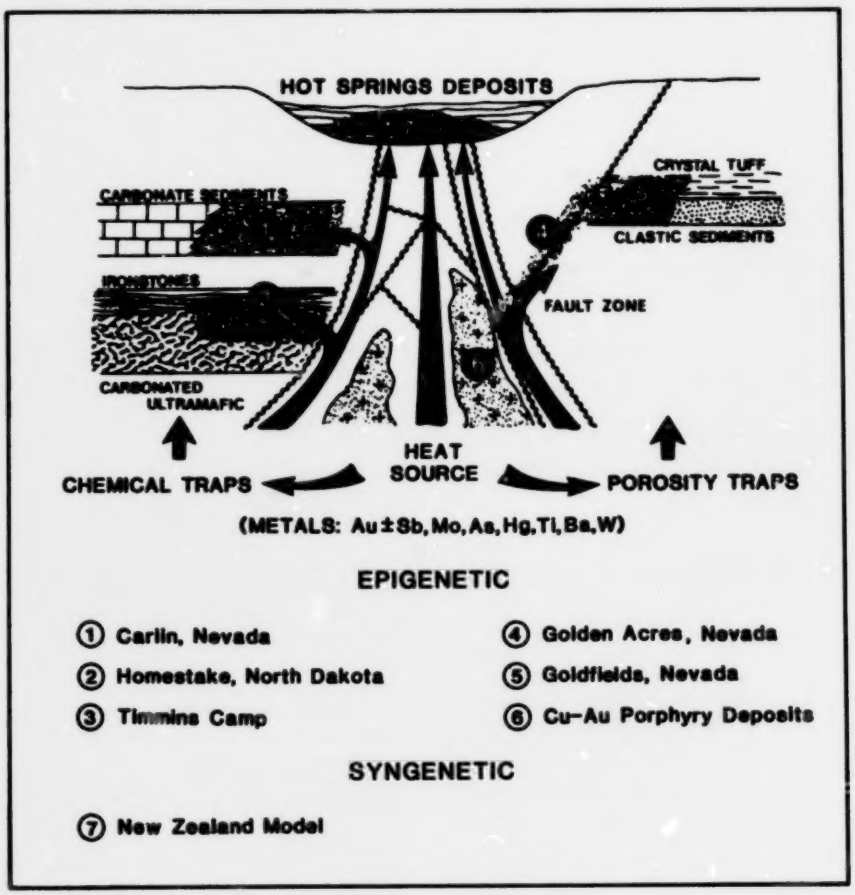


Figure 6. Epithermal model of the genesis of gold deposits.

lund. Trenching has more clearly exposed a quartz-carbonate vein system at 3 known locations on the property.

1. The Heron Bay Mine is located 250 m west of Highway 627, just south of the Canadian Pacific Railway line (Figure 2, Stop 3). During the period 1870 to 1880, several shafts and a small open cut were sunk from which a small tonnage of gold ore was produced (McKellar 1874). Trenching exposed a vein system (10 to 80 cm wide) which trends at 110° to 190° and can be traced 200 m. Shearing in the host rock is oblique to the vein system and is confined to the northern side of the vein. Samples of vein material, when slabbed, show several generations of vein development: (a) barren white quartz; (b) carbonate-rich; (c) tourmaline- and sulphide-bearing; (d) banded quartz-carbonate and barite. Sulphides identified are galena, chalcopyrite, pyrite, and molybdenite. Host rocks consist of coarse felsic pyroclastic rocks which appear bleached near the vein. A chip sample ran 0.22 ounce gold per ton and 3.00 ounces silver per ton across 0.82 m (McIlwaine *et al* 1982, p.52).

2. Approximately 200 m to the south a second vein, parallel to those at the Heron Bay Mine vein, has been stripped along strike for 40 m. The vein, hosted in felsic breccias, is from 0.25 to 1 m wide and is composed of quartz-carbonate with pyrite, galena, and tourmaline.

3. The Bowhill Mines occurrence is located 800 m west of Highway 627, 150 m south of the Canadian Pacific Railway. In 1937, Bowhill Mines Limited (Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) reported that an open cut had been made 200 feet long, by 9 feet wide, by 25 feet deep. A 500-pound test shipment of ore to the Ottawa Ore Dressing Laboratory ran 0.30 ounce gold per ton and 1.53 ounce silver per ton.

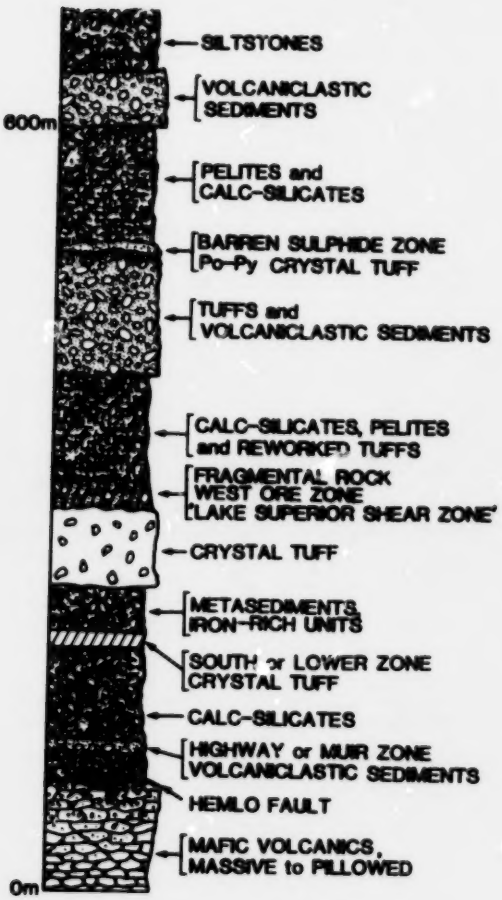


Figure 7. Table of formations along Highway 17 near Hemlo—Stop 10.

Recent mapping carried out by Derry, Michener, Booth, and Wahl Consultants has identified 8 "auriferous pyritic quartz sericite ± talc units". Two of these are currently the focus of exploration. All zones trend east-west. The main zone (3 to 6 m wide) occurs at the contact between a felsic agglomerate and a felsic tuff breccia containing mafic fragments. The south zone (2 m wide), 150 m south of the main zone, is hosted in felsic agglomerate. Both zones have been traced for 1 km. The mineralization at the Bowhill Mines occurrence is located in the main zone while that at the Heron Bay Gold Mine occurs to the north of the main zone. The trench at location 2 is in the south zone. Assay results across these zones are typically in the range of 0.02 to 0.06 ounce gold per ton across 0.4 to 1 m (Field Trip Guide, Pee-Kong-Gay Property, Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

Knut Kuhner Occurrence

The occurrence is located 1 km south of Page Lake (locally referred to as "¾ Mile Lake"), 10 km northeast of the Marathon Airport on the property of Gowganda Resources Incorporated (*see* Figure 2). The geology of the property was mapped by Milne (1967). It is underlain by felsic pyroclastic rocks on the west and mafic metavolcanics on the east. Metasediments, graphitic schists, pelites, cherts, and massive sulphides occur between the felsic and mafic metavolcanics. A lake bottom sediment geochemistry sampling program (Geological Survey of Canada, Open File Report 746) shows a large copper, lead, zinc, and mercury anomaly, similar to the anomaly at Manitouwadge, centred on Page Lake.

In 1983, drill logs with complete assays, from an exploration program by Kerr Addison Mines Limited in 1971, were added to the Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay. The best re-

sults were for drillhole KP-71-5 which intersected 18.2 feet of 0.08 ounce gold per ton and 1.16% Zn.

The mineralization encountered occurs as pyrrhotite, sphalerite, and pyrite hosted in felsic metavolcanics.

Airborne geophysics done by Shell Canada Resources Limited in 1977 shows a number of EM conductors (Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay)

Pryme Energy Resources Limited and March Resources Limited (McIntyre Cu-Ni Showing)

The property is located 16 km northeast of the junction of the Trans-Canada Highway 17 and the Manitouwadge Highway 614 (*see* Figure 2). The area was first staked by C. Von Klein in 1962 and optioned to McIntyre-Porcupine Mines Limited, who performed geophysical surveys (electromagnetic and magnetic), geological mapping, and drilled 28 holes. In 1964, Caravelle Mines Limited gained control of the group and optioned it to Falconbridge Nickel Mines Limited. It was staked by Pryme Energy Resources Limited and March Resources Limited in July 1982, and was then optioned to Noranda Mines Limited.

Exploration of the property defined 6 Cu-Ni and Cu-Zn occurrences; the most significant is "Showing Number 2". Two drillholes cut gold-bearing sulphide mineralization in "andesite". Assays are as follows:

Hole A_2 — 8.2 feet, Cu 1.05 %, Zn 0.8 %, Ag 0.40 oz/ton, Au 0.24 oz/ton

Hole W_1 — 7.0 feet, Cu 2.94 %, Zn 2.12 %, Pb 0.14 %, Au 0.094 oz/ton, Ag 1.54 oz/ton

(Assays by Falconbridge Nickel Mines Limited *in* 1970 Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

A semi-quantitative spectrographic analysis showed the presence of molybdenum. However, a drill program by Noranda Mines Limited was unable to confirm the past results (The Northern Miner, July 21 1983).

Summary of Exploration Guidelines

Geological Guides

The Hemlo deposit occurs at the contact between felsic crystal tuffs and metasediments (pelites, calc-silicates, and siltstones) (*see* Figure 8). Five felsic piles have been identified thus far at Heron Bay, Moose Lake, Theresa Lake, White River, and Pic River. Most are associated with metasediments. Near the Hemlo deposit, the associated crystal tuffs have been altered to sericite, green mica, tourmaline, and hematite. Similar alteration (sericite and green mica) has been reported from properties on the Heron Bay, Moose Lake, and Theresa Lake felsic piles. The significance of pelites in the area of the deposit is not understood but they may represent alteration products.

Geophysical Guides

Both VLF and magnetometer methods can be used to trace stratigraphic marker units; the main ore zone did not respond to these methods. Induced Polarization surveys did indicate the presence of the ore zone; however, there are many Induced Polarization responses in the deposit stratigraphy. Research by P. Sivenas (University of Toronto) is being conducted on the applicability of the S.P. method in the Hemlo area.

Geochemical Guides

The deposit responds well to both humic gold surveys and "B" soil horizon gold surveys. In humic gold surveys, backgrounds are <10 parts per billion and anomalies are 40 parts per billion; in "B" soil horizons, the backgrounds are <14 parts per billion and the anomalies are up to 430 parts per billion (Quartermain *et al.* 1983). Soil sampling done by R. Newman on the Golden Sceptre Resources Limited property (Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) indicates anomalies up to 10 000 parts per billion associated with the "Fracture Zone" occurrence. Molybdenite in "B" soil horizons also indicates the presence of the deposit.

Further information on geochemical surveys is presented in the section on "Quaternary Geology—Hemlo Area" by Patterson *et al.* (1984).

Barite Occurrences in the Hemlo Area

Introduction

A barite-rich horizon has been identified in the Hemlo area by Ore Quest Consultants Limited. The western end of the horizon is located 10 km east of Marathon (*see* Figure 9). The baritic unit, which trends 95° and dips 80°S, can be traced by geology and geophysics an additional 6 km east, across properties held by Cal Dynamics Energy Corporation, Kadrey Energy Corporation, Rideau Resources Corporation, Padre Resources Limited, and Northern Eagle Mines Limited. On a regional scale, the barite-rich horizon occurs at the contact between mafic pillowed metavolcanics to the south and metasediments and felsic metavolcanics to the north (*see* Figure 10). The baritic horizon contains units of massive barite, graphitic schist, green mica schists, carbonate, chert-pyrite, and sericite schist. Geophysically, the horizon is marked by an EM conductor (graphitic schist), Induced Polarization anomalies (pyrite zones), and a break between high

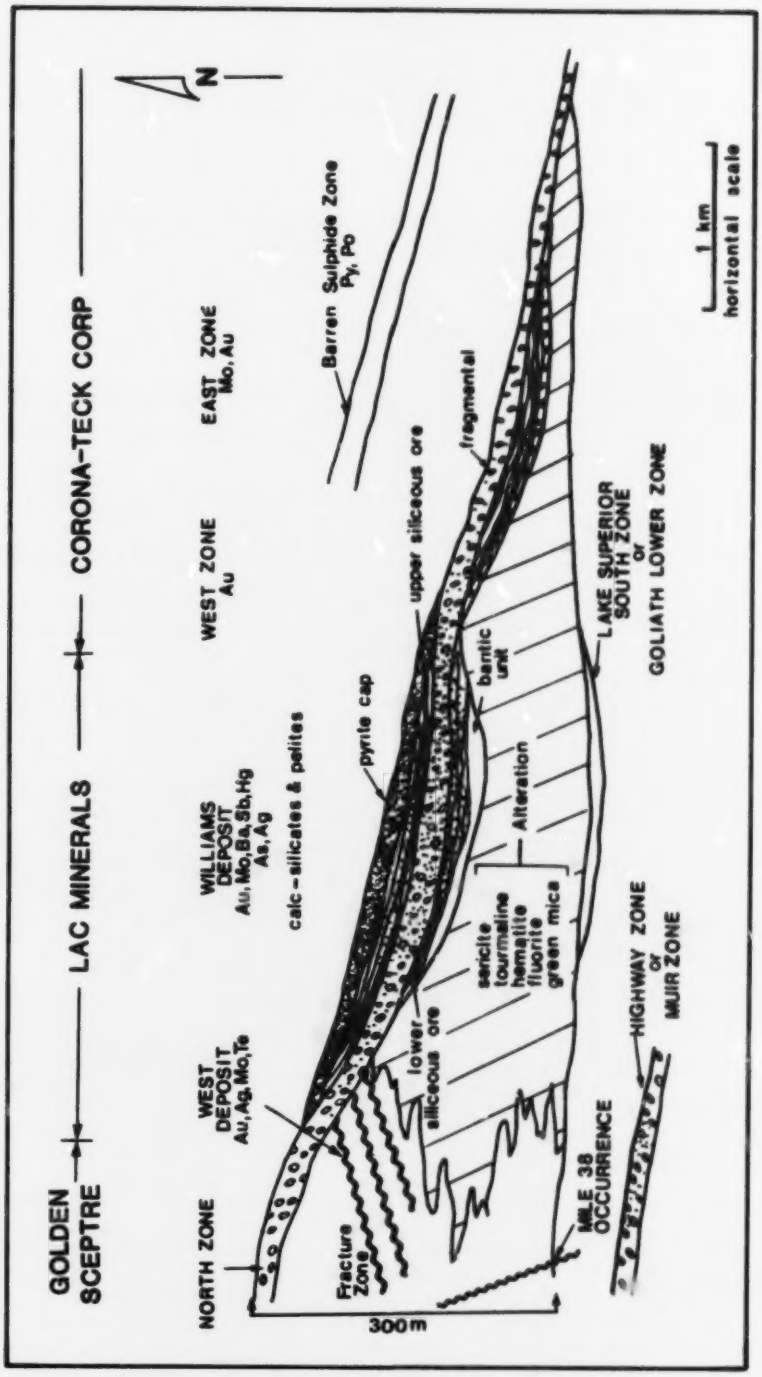


Figure 8. Stratigraphic relationships at the Hemlo deposit.

magnetics (mafic metavolcanics to the south) and low magnetics (metasediments to the north).

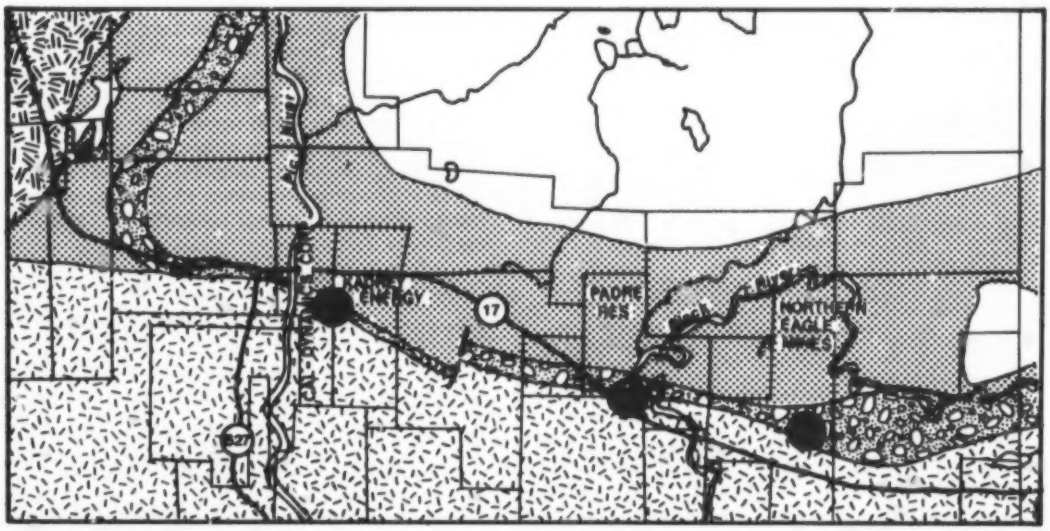
The deposits are being examined by the companies both for the relationships between gold and barite in the Hemlo deposit, and for industrial barite potential.

Northern Eagle Mines Limited

The occurrence is located 1.6 km east of the Black River and 0.5 km north of the Trans-Canada Highway 17 (*see* Figure 9). The occurrence has been trenched, exposing a unit of massive barite 1 to 2 m thick, with a strike of 110°, and dipping 80°S, for 60 m. The massive barite is pale grey-white in colour with poorly developed bedding of carbonate- and pyrite-rich layers, 1 to 2 mm thick, that make up <10% of the rock. Gold assays are generally <400 parts per billion Au. The stratigraphy consists of mafic metavolcanics and metasediments to the south, followed by a quartz-feldspar sill (3 m wide) with lenses of graphitic schist, followed by the barite unit. This is overlain by a sericitic schist (with abundant green mica), graphitic schists, and metasiltstone. Further to the north (1 km), metapelites containing garnet, staurolite, and andalusite are exposed.

Padre Resources Limited

The barite-rich horizon outcrops on the Padre Resources Limited property, approximately 700 m west of the Black River Bridge on Highway 17, and 200 m north of Highway 17 (*see* Figure 9). Stripping has revealed a barite horizon, up to 1 m wide. A thin section shows the rock to contain up to 70% barite with minor pyrite, quartz, and carbonate. An assay of this material gave 35.7% BaO, with a specific gravity of 3.5 (Geoscience Laboratories, Ontario Geological Survey, Toronto). All rocks strike at 110° and dip steeply to the south. To the south of the barite-rich horizon (*see* Figure 11), are massive mafic metavolcanics intercalated with graphitic interflow metasediments. Approximately 25 m below the barite-rich horizon is a fragmental unit consisting of fragments of mafic metavolcanics and graphitic schist in a biotite-rich matrix. A



PROTEROZOIC

Alkalic Intrusive Rocks (Coldwell Complex)

ARCHEAN

Monzonite (Gowan Lake Pluton)

Felsic Volcanics (Tuff to Lapilli Tuff)

Metasediments

Mafic Volcanics (Pillowed to Massive)

Barite Occurrence

Figure 9. Barite occurrences in the Hemlo area (after Ontario Geological Survey Map 2439 and Terrae Drafting Services Hemlo Map).

quartz-feldspar porphyry, with distinctive blue quartz-eyes, intrudes parallel to foliation and is in contact with a biotite-green mica-carbonate schist containing minor fluorite. This rock contains 20% apple green mica. A quantitative spectrographic analysis of the green mica indicates more than 0.1 to 0.5% barium, 0.1 to 0.5% chromium, and 0.05 to 0.1% strontium (Geoscience Laboratories, Ontario Geological Survey, Toronto). This is followed by 1 m of the barite-rich rock.

Directly above this unit is a sericite-carbonate schist containing up to 15 to 20% pyrite. Assays of this unit returned up to 42 parts per billion gold (Geoscience Laboratories, Ontario Geological Survey, Toronto). To the north of this unit is a siltstone with graded beds indicating tops to the north.

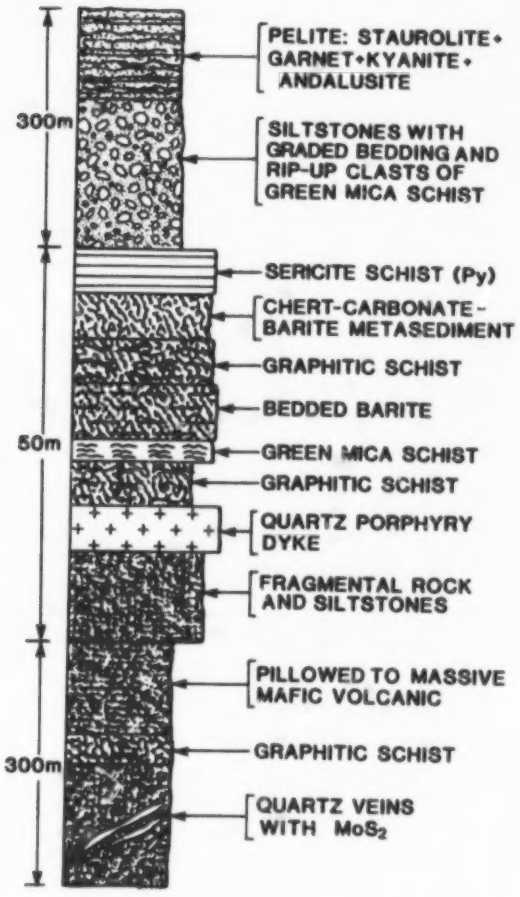


Figure 10. Table of formations for barite occurrences.

In drill core, a number of cataclastic zones, consisting of wallrock fragments in a fine grained matrix stained red by hematite, are associated with the barite zone. In thin section, some of the fragments are lamprophyres similar to those associated with the Coldwell Complex (age = 1.04 billion years). Pelitic metasediments which occur to the north of the siltstone contain andalusite, kyanite, sericite, and quartz. The assemblages are indicative of low to mid-amphibolite grade metamorphism.

Kadrey Energy Corporation and Cal Dynamics Energy Corporation

Stripping has revealed a barite-rich unit near the claim boundary between Kadrey Energy Corporation and Cal Dynamics Energy Corporation. The occurrence is located 2 km east of the Pic River, and 1 km south of Highway 17. The barite-rich unit, 2.8 m wide, striking 85° and dipping 80°S, is associated with graphitic schists and pyrite-carbonate metasediments. The barite unit is light grey-white in colour with minor beds of pyrite-chert-carbonate. In drill core, the massive barite gradually grades into pyrite-rich chert-carbonate. Drilling on a series of Induced Polarization anomalies has intersected 3 parallel barite units, up to 3 m wide, associated with sericite-green mica schists on the footwall. To the north of the stripped barite occurrences are siltstone units, with graded bedding indicating tops to the north. In drill core, rip-up clasts rich in green mica occur within some of the siltstone units. The rocks are cut by numerous lamprophyre dikes. The drill-holes cut a number of cataclastic breccias. An assay of the baritic sediment returned 45.9% BaO with a specific gravity of 3.8 (Geoscience Laboratories, Ontario Geological Survey, Toronto).

Origin of Barite Deposits

A brief literature search on barite deposits was made; Brobst (1975) and Morse (1980) provide summaries.

Bedded barite deposits occur in Arkansas, Washington, California, and Nevada. A summary of their geology was reported by Morse (1980):

"The most important commercial deposits are of bedded barite. The principle locations of these deposits are Arkansas, California and Nevada. The barite in these areas is generally dark gray to black and has a characteristic fetid odor when struck with a hammer. The beds, which vary from several inches to over 500 feet thick, occur interbedded with dark chert and siliceous siltstone and shale. In most of the deposits, the barite is laminated. In some areas, barite nodules and rosettes make up a large part of the beds. Many of the beds contain 50 percent to 95 percent barite."

The reader is referred to Shawe *et al.* (1969) for further details on the Nevada barite occurrences, to Mills (1971) who describes the deposits in Washington, and to Zimmermann and Amstutz (1964) for deposits in Arkansas. Deposits of bedded barite have also been reported in the Yukon Territory (Blusson 1976). These workers suggest a

sedimentary origin for the barite, citing as evidence the occurrence of fossils, crossbedding, barite clasts in associated conglomerates, and organic matter in the baritic rocks.

A number of other occurrences of bedded barite are also known: in the Archean of Western Australia—the North Pole Deposit (Hickman 1973); South Africa—Fig Tree Group (Heinrichs and Reimer 1977); and Zimbabwe—Bulawayan Group (Morrison 1970). These workers cite similar evidence for a sedimentary origin as those in the United States, namely primary sedimentary bedding, a stratigraphy that can be traced for several kilometres, and clasts of barite in conglomerates.

Earlier workers in Arkansas (e.g. Scull 1958) suggested that barite was formed as the result of hydrothermal solutions replacing carbonate. However, most of these occurrences are distal to intrusions that might have been a source of fluids. Barite at Carlin, Nevada occurs in 2 fashions—as enrichments in silicified carbonates, and as veins (Radtke *et al.* 1980). Both modes of occurrence at Carlin are thought to be replacements of primary carbonate by epithermal solutions.

The barite occurrences at Hemlo appear to be the first Archean occurrences documented in Canada. Barite occurrences south of Timmins, Ontario appear to be Proterozoic in age (I. Cameron, Research Geologist, Geological Survey of Canada, Ottawa, personal communication 1983) as are occurrences in the Thunder Bay area.

The Ore Quest Group of occurrences may be sedimentary in origin: they are finely bedded; interfingered with cherts, carbonate, and graphitic schists; they occur in the same stratigraphic position along a strike length of at least 6 km; and rip-up clasts of mica schist, containing a green mica which is associated with the baritic horizon, have been found in siltstones stratigraphically above the baritic horizon.

In comparing the barite at the Goliath deposit to the Ore Quest occurrences, there are differences. The most nota-

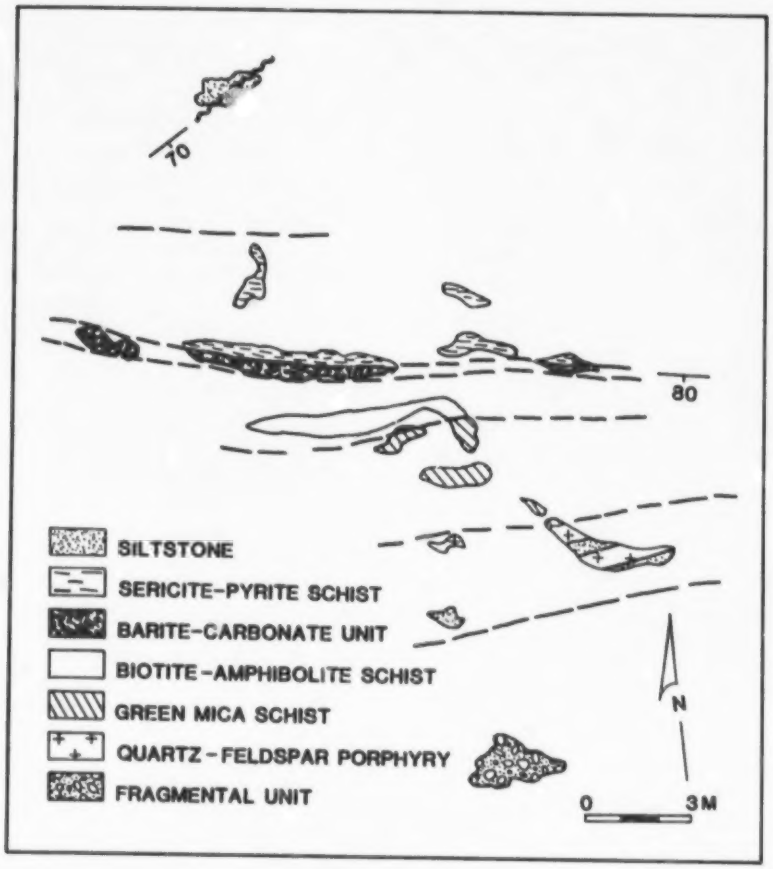


Figure 11. Padre Resources Limited barite occurrence.

ble difference is the degree of recrystallization in the Goliath deposit barite. This has resulted in coarser and occasionally bladed crystals of barite with a whiter colour. Recrystallization has obscured any fine sedimentary textures, which are evident in the Ore Quest occurrences. The general stratigraphy of both occurrences is similar, with the notable absence of crystal tuffs in the Ore Quest occurrence. The presence of a green mica, which appears to be an alteration product, occurs at both locations. The barite in the Goliath deposit tends to be confined to the footwall, adjacent to wider sections of the gold ore zone.

Barite is absent in the Corona East Ore Zone. Some barite occurs as thin (1 cm) beds in the Lac Minerals Limited deposit. The stratigraphic relations between the Hemlo gold deposit and the Ore Quest barite occurrences is unknown.

Research on the barite deposits is planned by P. Fralick (Lakehead University) and K. Butella (Ore Quest Consultants, Vancouver). Isotopic studies are being done by I. Cameron (Geological Survey of Canada). The industrial quality of the barite is being tested by the Geoscience Laboratories, Ontario Geological Survey, Toronto.

Research in the Hemlo Area

In addition to company programs, at the time of writing there were 23 research projects being carried out by various Universities, the Federal Government, and the Ontario Provincial Government.

These projects can be broken down into the following groupings:

(A) Regional Geology: G.M. Siragusa (Ontario Geological Survey) is continuing regional mapping to the east of Muir's (1982a, 1982b) map areas. M. Ferreira (University of Western Ontario) is doing a regional study of the metamorphic petrology.

(B) Local Geology: T.L. Muir (Ontario Geological Survey) will work on a detailed map from Rous Lake to Highway 614. H. Hugon (University of Toronto) will study the structural geology in the same area. I. Cameron (Geological Survey of Canada) and K. Hattori (University of Ottawa) are carrying out isotope studies on the sulphides and sulphates of the deposit. D. Harris (Geological Survey of Canada) is conducting studies on the ore mineralogy. Detailed studies of the individual sections of the deposit are also in progress.

1. Williams property (Lac Minerals Limited): Bob Barnett (University of Western Ontario) is doing a Ph.D. thesis on the deposit. Three B.Sc. theses are also being done at the University of Western Ontario: P. Neweglowski —Ore Zone Petrology; K. Powell—Hanging Wall Alteration; and P. Trowell—Gold Distribution in the Williams deposit.
2. International Corona Resources Limited deposit (Teck Corporation): Ron Burk (Queen's University) is doing a M.Sc. thesis on the geology of the International Corona Resources Limited deposit.
3. Goliath Gold Mines Limited deposit (Noranda Mines Limited): R. Kuhns is doing a Ph.D. thesis at the University of Minnesota on the geology of the Goliath deposit. T. Hughes (Carleton University) is studying the metamorphic petrology of the site.

(C) Exploration Guidelines:

1. Geochemistry: J.A.C. Fortescue (Ontario Geological Survey) is carrying out soil and humic geochemistry studies on the Williams deposit. P. Friske (Geological Survey of Canada) is conducting regional lake bottom sediment sampling. R. Goad (University of Western Ontario) is looking at regional geochemistry for Noranda Mines Limited. R. Kristjansson (Ontario Ministry of Natural Resources, Thunder Bay), and R. Geddes and G. Jones (Ontario Geological Survey) are carrying out Quaternary geology studies.
2. Geophysics: P. Sivenas (University of Toronto) is testing an experimental S.P. (Self Potential) unit on a number of properties in the area.

Road Log—Hemlo Area Field Trip
(Figure 2)

Stop Locations	Distance (km)	Distance Between Stops
1. Intersection of Highway 17 and Highway 626 (turn-off to Marathon)—proceed east along Highway 17 to Highway 627 (turn-off to Heron Bay)—turn south then proceed south to Pukaskwa Park checkpoint—take first road west—park in parking lot—take Playter Trail southwest for 500 m to the shore of Lake Superior—Stop 1 is a large low-point just south of the trail.	0.0 6.9 21.6 22.0	0.0 6.9 14.7 0.4
2. Return to vehicle—proceed north along park road—Stop 2 is a large outcrop on both sides of road.	23.4	1.4
3. Drive north along the park road and Highway 626—Stop 3 is the first outcrop south of the Canadian Pacific Railway tracks.	32.2	8.8
4. Continue north along Highway 626—Stop 4 is the first outcrop south of the power lines.	35.4	3.2
5. Continue north along Highway 626 to Highway 17—turn west—Stop 5 is 3.4 km west, just west of the power lines.	37.2 40.6	1.8 3.4
6. Continue west on Highway 17—Stop 6 is on the south side of the highway, near the centre of a long low outcrop.	42.3	1.7
7. Proceed east on Highway 17—Stop 7 is 1 kilometre east of the Black River bridge; walk 1 km north along drill road.	53.8 54.8	11.5 1.0
8. Continue east along Highway 17 to Rous Lake Pit Road—turn north—continue for 1.5 km to Stop 8.	66.8 68.3	12.0 1.5
9. Return to Highway 17 and proceed east—continue past a microwave tower on south side of highway—Stop 9 is on the north side of highway, just east of a small bush road—the Canadian Pacific Railway tracks are just south of Highway 17 at this point.	74.8 76.7	6.5 1.9
10. Proceed to Stop 10 which is on the north side of Highway 17, just north of an abandoned loop in Highway 17.	77.1	0.4
11. Proceed east along Highway 17 to the St. Lambert Drill Road, just east of Moose Lake. Moose Lake, north side of Highway 17— St. Lambert Drill Road— Teck Access Road— (*see* Figure 5)	 78.8 79.4 80.4	 1.7 0.6 1.0
11A. Outcrop on south side of Highway 17, directly south of Moose Lake.		
11B. Outcrop 200 m west of St. Lambert's Drill Road on north side of Highway 17.		
11C. Outcrop just west of St. Lambert's Drill Road on north side of Highway 17.		
11D. Proceed 500 m north along St. Lambert's Drill Road; the pit is 100 m west of the road.		

Stop Locations	Distance (km)	Distance Between Stops
11E. Proceed to 500 m east of St. Lambert's Drill Road on north side of Highway 17.		
11F. Proceed to 600 m east of St. Lambert's Drill Road on north side of Highway 17.		
11G. Proceed to the north side of Highway 17 to just before a gentle northward bend in the road.		
11H. Proceed along the north side of Highway 17 to opposite the Cedar Creek Road.		
11I. Proceed about 500 m east on north side of Highway 17, to just west of the guard post.		
11J. Proceed to the first outcrop on the north side, to the east of the last Stop (11I).		
11K Proceed to the first outcrop west of Cedar Creek.		
12. Proceed east along Highway 17 to the Noranda Access Road—Stop 12 is just to the east.	81.8	1.4

Stop Descriptions

Stop 1

Playter Harbour Sequence (Muir 1982a)

(Note—inside Pukaskwa Park, no hammers)

This outcrop is typical of the high-iron tholeiitic basalts of the Playter Harbour Sequence. A series of south facing flow units, 10 to 15 m thick, striking at 100° can be identified. These consist of a massive lower unit 5 to 7 m thick and a pillowed top 5 to 8 m thick. The massive unit consists of a basal chill zone, 10 to 15 cm thick, that gradually becomes coarse grained (gabbroic) over a distance of 2 to 3 m. Above this, the massive unit becomes finer grained with irregular and indistinct pillows. The overlying pillows have chloritic selvages from 5 to 10 cm wide. Variolites are common in the margins of the pillows. Deformation has both flattened (2:1) and lineated (5:1) the pillows.

On the northeast edge of the outcrop, a number of cherty sulfide-rich interflow sediments, up to 1 m wide, may be observed. In general, these sediments are highly deformed and intruded by felspar-porphyry dikes and barren quartz veins.

Proterozoic diabase dikes and lamprophyre dikes also occur in the area.

Excellent exposures of lapilli-tuffs and clastic metasediments can be observed by following the park hiking trail north along the shore of Lake Superior.

Stop 2

Heron Bay Metasediments Sequence

(Note—inside Pukaskwa Park, no hammers)

Exposed on both sides of the highway are highly deformed metasediments typical of the Heron Bay Sequence. The metasediments consist of siltstone, commonly with graded bedding and rip-up clasts, and graphitic argillites interbedded with units of tuff or tuffaceous metasediments. Two lineations are evident: 110/50W and 118/20W. Refolded folds are exposed in the first road-cut north, near the base of a small hill. The fold axis of the secondary folding is 115/20W, parallel to one of the lineations.

Stop 3

Felsic Pyroclastic Breccia of the Heron Bay Sequence

In general, the felsic metavolcanics of the Heron Bay Sequence consist of coarse pyroclastic breccia that grades into lapilli tuffs and tuff to the east. The felsic pyroclastic breccia at this stop consists of blocks of feldspar-quartz porphyry in a fine grained chloritic matrix with rare blocks of coarse feldspar porphyry and chloritic schist. In general, the blocks range from 15 to 30 cm and volumetrically make up 60 to 80% of the rock. Indistinct bedding is evident on the southwest corner of the outcrop. In cut slabs the blocks are commonly lineated as much as 10:1 with only minor flattening in the plane of foliation.

On the northeast side of the road-cut a narrow shear (110/80S), filled with lineated carbonate lenses, cuts the pyroclastics. Coarse pyrite occurs adjacent to the shear. Similar shears host the Heron Bay Gold Mine vein (200 m west of Lecour's Store); *see* section on "Gold Occurrences in the Hemlo Area". A diabase dike, 5 m wide, cuts through the outcrop.

Stop 4

Mafic Metavolcanics of the Heron Bay Sequence

Complete south-facing mafic metavolcanic flow units, consisting of hyaloclastite, pillows, and massive units with flow banding, are exposed. The flow units are 9 m thick; flattening of the pillows is at 110°, flow banding at 80°, and lineation of the pillows is at 80/35W. Interflow sediments, occurring as sulfide-bearing graphitic schists, are exposed under the first power line tower west of the highway.

Stop 5

Dunlop Cu-Ni-Mo Occurrence

This occurrence is located within the Coldwell Alkalic Complex. A summary of the exploration history was given by Muir 1982a:

"W.B. Dunlop holds five surveyed claims numbered TB104118 to TB104122 inclusive. The claims straddle Highway 17 and are underlain by gabbro and contact-metamorphosed pyroclastic rocks. Interest in the area originated in the early to middle 1950s with the blasting of a rock cut for Highway 17 (Trans-Canada Highway) which revealed gabbro mineralized with chalcopyrite and pyrite extending over an area about 61 m by 15 m (Assessment Files Research Office, Ontario Geological Survey, Toronto)".

"Kinasco Exploration and Mining Limited originally held the ground and in 1955 a preliminary self-potential survey was undertaken along with five exploratory X-ray diamond drill holes. The self potential survey outlined an anomaly 610 m by 38 m (Assessment Files Research Office). Diamond drilling (amount unreported) intersected massive pyrite and chalcopyrite in four out of five holes. One intersection assayed 3.5 percent copper over 3 m, and another assayed 1.2 percent copper over 10 m. (Assessment Files Research Office). Ten diamond drill holes totalling 1928 m were subsequently drilled in 1956. Most of the holes intersected medium- to fine-grained gabbro, highly metamorphosed sedimentary rocks, and minor monzonite. Massive and disseminated sulphides consisting mostly of pyrrhotite, pyrite, and minor chalcopyrite, were intersected in all of the holes (Assesment Files Research Office)."

"In 1961, International Nickel Company of Canada Limited restaked the lapsed claims and completed a gravimetric survey over the main showing (Assessment Files Research Office). The claims subsequently lapsed. In 1962, Conwest Exploration Company Limited made a preliminary investigaton of the property, and in 1964 sank two diamond drill holes totalling 306 m. The best assays from this core gave nil values for gold, 0.03 ounces silver per ton, and 0.59 percent copper over 3 m, averaging 0.31 percent copper throughout (data on file at the Assessment Files Research Office, Ontario Geological Survey, Toronto). The claims are currently registered under W.B. Dunlop."

"The gossan zone in the roadcut has undergone considerable weathering since 1956. Flat-lying contact breccia forms the host for the mineralization. Although some mineralized zones reportedly ran 2 percent copper over widths of up to 1.5 m (Assessment Files Research Office, Ontario Geological Survey, Toronto), a grab sample selected by the writer, containing chalcopyrite and pyrite, assayed 0.85 percent copper and negligible lead, zinc, and nickel. A few traces of molybdenite were seen during the field examination."

The Coldwell Complex (1.044 by old, Mitchell and Platt 1982a) consists of 3 centres of intrusion: (1) gabbro, ferroaugite, and syenite—forming the eastern margin of the complex; (2) biotite gabbro, nepheline syenite—Pic Islands and Neys Penninsula; and (3) syenite and quartz syenite—on the north and west side of the complex. At this stop, centre (1) gabbros with abundant inclusions of wallrock cut metasediments, a breccia occurs along the contact (southwest end of outcrop). The gabbro is intruded by ferroaugite syenite.

The sulphide assemblage pyrite, chalcopyrite, and molybdenite is typical of Coldwell Complex mineralization. It has been suggested that mineralization resulted from assimilation of sulfide-rich wallrocks (Naldrett 1966).

Stop 6

Layered Gabbros of the Coldwell Complex

This stop was described by Mitchell and Platt (1982b):

"The gabbros are composed of olivine (Fo_{67-43}), augite, plagioclase (An_{60-35}) and minor orthopyroxene (En_{55-66}) (Lum 1973). The orthopyroxene may be a product of assimilation of Archean metasedimentary rocks, a xenocryst derived from the pyroxene hornfels thermal aureole or a relict high pressure phase. The gabbro has been extensively prospected for its copper potential as accumulations of pyrrhotite and chalcopyrite, with minor pentlandite, cubanite, pyrite, bornite, arsenopyrite and mackinawaite (Watkinson et al. 1973; Lum 1973) are common."

"The excursion Stop is close to the contact between the gabbro and the ferroaugite syenite. Many pegmatites of ferroaugite syenite cut the gabbro at this locality. The gabbro contains variable amounts of Archean xenoliths. Here the gabbro shows all transitions from massive homogeneous gabbro to rocks with well developed igneous layering. The layers are not traceable over long distances and do not serve to outline the structure of the gabbro intrusion."

Stop 7

Northern Eagle Barite Occurrence (Figure 9 and Figure 10)

See under "Barite Occurrences in the Hemlo Area" above. Permission is required to visit this occurrence.

Stop 8

Rous Lake Gravel Pit (Figure 12)

The geology of the Rous Lake Borrow Pit (Figure 12) was described by K.G. Fenwick, Mineral Resources Coordinator, North Central Region, Ministry of Natural Resources, Thunder Bay (unpublished report; Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay):

"During the past six years this borrow pit has become famous as the "Galloping Pit near Marathon" (The Times-News, [Thunder Bay], June 20, 1973, p.4). Due to this interest and possible geotechnical problems, the Regional Geologist's Office was requested to research the pit."

"In the mid-fifties, this borrow pit was established to provide sand as a roadbase for the construction of Highway 17 (R.J. MacLean, written communication). An air photograph, taken in 1962, indicated that the pit was 277 m (910 feet) long in the southeast direction, 181 m (595 feet) wide in the east-west direction and approximately 5 m (18 feet) deep (depth measured in the field). The pit, in 1962, was closed in regards to the Black River which is 33 m (100 feet) north of the pit. The next available photograph was in 1971 and a marked change has occurred in the pit. The pit wall, in its north end, has been broken through to the Black River. The pit is now approximately 29 m (95 feet) deep. [The table] below will emphasize the pit's growth."

	EAST– WEST DIRECTION		SOUTHEAST DIRECTION	
	Feet	Metres	Feet	Metres
1962	595	181	910	277
1971	900	274	1,150	351
1974	1,050	320	1,250	381
1976	1,150	351	1,290	393

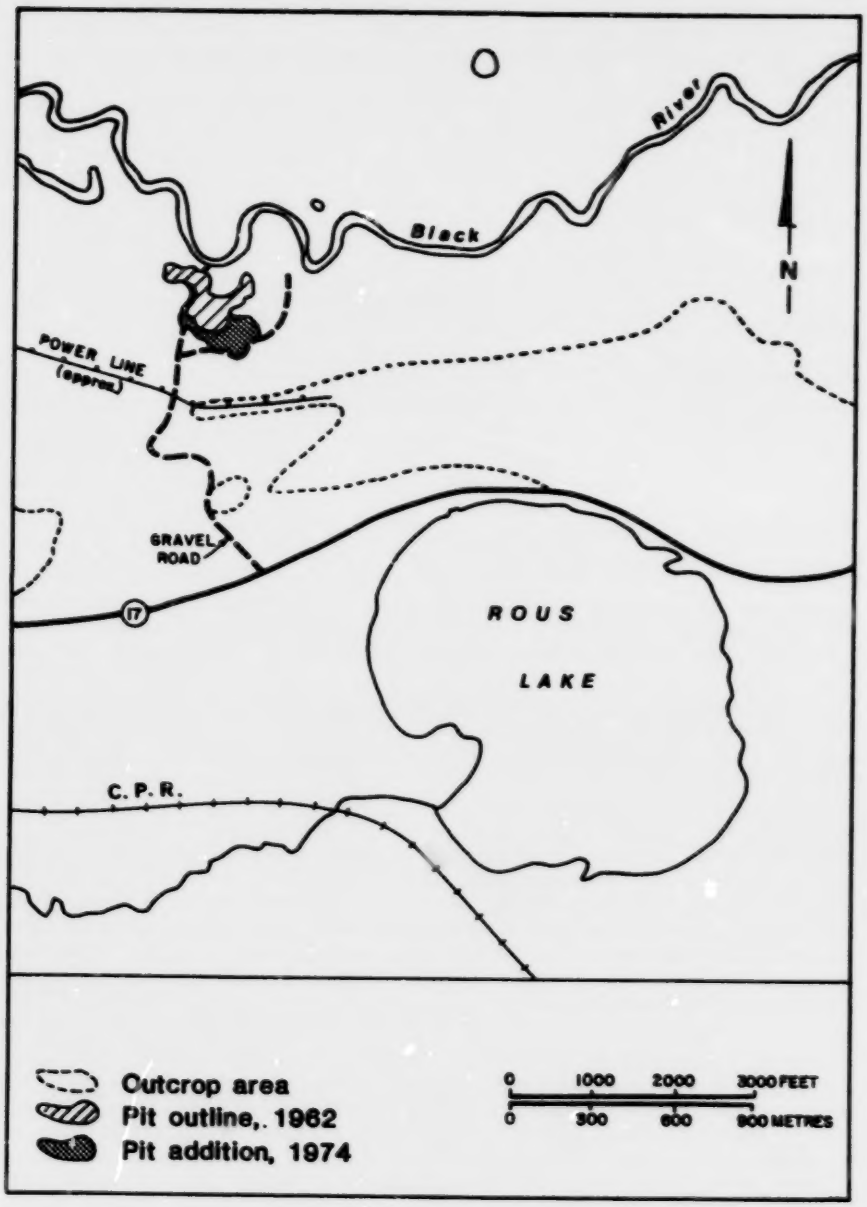


Figure 12. Rous Lake gravel pit—Stop 8.

"The pit, presently, is fairly stable in [its] north and west sides. Therefore, the main growth area is in the southeast direction and in the northwest canyon."

"Since we do not have any information on when the pit began to move, we can only figure out its horizontal movement in the time period from 1971 to 1976. Therefore, the pit has grown in the east direction at approximtely 16 m (50 feet) a year and in the southeast direction at approximately 6 to 10 m (20 to 33 feet) a year. This land movement has engulfed portions of two roads and a considerable amount of tree land."

"A field visit of the study area indicated that the top 8 m (25 feet) in the pit is composed of a coarse silt to very fine sand. The interlayered clay and silty fine sand in the lower 21 m (70 feet) forms a cyclic sequence consisting of approxiatey 23 cm to 182 cm (9 inches to 92 inches) of silty fine sand followed by 15 cm to 4 cm (0.6 inches to 1.6 inches) of clay. There were twenty-six clay-sand cycles noted in the pit. George Burwasser (written communication) states:"

'The sand unit is deposited in 2 to 5 layers of trough-cross laminated beds each separated by a minute lamination of silt. These are conformably overlain by 1 to 3 platey beds of intercalated very fine sand and clay which are, in turn, overlain conformably by 2 or 3 platey beds of clay containing the classical "light-dark" sequencial relationship of varves, including microboudinage features and current stirred inclusions. A sharp erosional contact marks the uppermost clay surface of the cycle.'

"Water has been noted flowing from the walls in all corners and sections of the pit. The water flowage from the southeast portion of the pit and the northwest canyon appears to be the fastest and in greater volume than in the rest of the pit. It is believed that Rous Lake, which is 975 m (3,000 feet) to the southeast of the pit, is the main source of water to the southeast canyon. The topographic map of the area indicates that Rous Lake is 900 feet above sea level, the river flowing west out of Rous Lake is 850 feet above sea level and that the Black River is 800 feet above sea level. A small unnamed lake, 1.5 km (1 mile), west of the pit may be contributing water to the northwest canyon. This lake is located between 800 foot and 850 foot contours on the topographic map (Marathon 42D/9E). It also appears that the rain water, run-off from the spring melt etc., percolates down through the fine sand and then flows along the tops of the impermeable clay layers into the pit from all sides."

"A study of the surficial maps (Boissoneau 1965; Zoltai 1965) indicated that a 6.4 km (4 mile) wide, east and northeast trending lacustrine deposit of varved clay, silt, fine sand and sand underlies the area. This deposit, which is approximately 80 km (50 miles) long is bisected by the Black River for its entire length. An important point, noted on the surficial maps, is that Rous Lake is the only lake of any major size, located on this lacustrine deposit. Therefore, a major water source is needed, for this problem to occur."

"The water flowing out of the pit and into the Black River is heavily sediment laden. As a result, the walls of the pit are being continuously undercut, as this material flows out. The water west of the entrance to the pit, in the 1974 and 1976 photos, is extremely cloudy in comparison to water to the east of the entrance. A rough calculation indicates that approximately 1.5 million tons of sand, silt and clay has been transported out of the pit by water between 1976 and 1962."

Stop 8 illustrates some of the problems encountered in the area by basal till sampling programs.

Stop 9

Mile 38 Occurrence

A shear zone, 5 m wide, occurs at the contact between metasediments to the west and a syenitic intrusion to the east. Within the shear, sericite-chlorite schist contains pyrite and minor chalcopyrite. Grab samples assayed at the Geoscience Laboratories, Ontario Geological Survey, Toronto, returned 0.04, 0.10, <0.01 and <0.01 ounce gold per ton.

This shear (Figure 3, Number 15) may be part of a large fault structure which cuts the felsic metavolcanics which form the footwall rocks of the Hemlo deposit (G. Pierce, project geologist, Noranda Mines Limited, personal communication 1983).

Stop 10

Muir Zone or Highway Zone (Figure 7)

See section on the "Golden Sceptre Resources Limited" property for a description of the occurrence. Walking to the east along the north side of Highway 17, a series of felsic metasediments and calc-silicates cut by feldspar porphyry sills can be observed. At the east end of Finger Lake (referred to as "Cigar Lake" by the Ontario Ministry of Transportation and Communciations) the contact between massive mafic metavolcanics to the south and metasediments to the north is exposed. The contact is marked by a 3 m wide zone of chloritic schist (possibly a sheared mafic dike) referred to as the Hemlo Fault (*see* Figure 7). The zone can be traced parallel to stratigraphy for 8 km (Bartley and Page 1958). Locally, feldspar porphyry sills have intruded into the zone, and have been replaced by tourmaline (grab sample returned less than 0.01 ounce gold per ton (Geoscience Laboratories, Ontario Geological Survey, Toronto).

Stop 11

Hemlo Deposit Stratigraphy (Figure 5 and Figure 7)

Refer to Figures 5 and 7. This section is based, in part, on an unpublished field trip guidebook, prepared by R. Quartermain, Teck Corporation.

Stop 11A

Metasediments

On the south side of Highway 17, just below Moose Lake, a roadcut exposes thinly bedded metasiltstones and calc-silicates. These are cut by a diabase dike at the east end of the outcrop. A pyrite-rich unit may be an eastern extension of the Muir Zone, (a grab sample returned 0.01 ounce gold per ton; Geoscience Laboratories, Ontario Geological Survey, Toronto).

Stop 11B

Contact Between Metasediments and Felsic Metavolcanics (Figure 13) Lower, or Lake Superior South, Ore Zone

At this outcrop, the contact between a metasediment, cut by feldspar porphyry sills, and a quartz-eye sericite schist, containing pyrite, minor molybdenite, tourmaline, and green mica, is exposed (*see* Figure 13). The contact shows a number of tight folds and boudinaged quartz veins. Assays of quartz-eye sericite schist from the lower zone of the Goliath deposit returned 0.32, 0.02 and (5 samples) <0.01 ounce gold per ton (Geoscience Laboratories, Ontario Geological Survey, Toronto). This unit is not ore-bearing to 1000 m down dip direction (R. Quartermain, project geologist, Teck Corporation, personal communication 1983).

Stop 11C

Porphyry Sills Cutting Metasediments

Two types of porphyry sills cut the metasediments in this outcrop. The first type consists of 40% fine feldspar phenocrysts in a fine grained groundmass. The second type consists of 20% coarse feldspar phenocrysts, commonly with magnetite at the core, in a fine biotite-rich matrix. On the south side of the highway, the metasediment contains thin (2-3 cm wide) magnetite-rich bands.

Stop 11D

The Lac Trench (Figure 14)

Note—permission to visit the trench must be obtained from Lac Minerals Limited. The trench is described in the section on the "Lac Minerals Limited" property (*see* Figure 14).

Stop 11E

Footwall Quartz-Sericite Schist (Figure 15)

The outcrop consists of a fine grained quartz-eye sericite schist (tuff) cut by feldspar porphyry sills. This unit thickens to 450 m, at a distance of 2 km to the west, and tapers to the east. Bedding-like features are defined by variations in the number of quartz eyes. A small scale fold is also present.

Stop 11F

Corona West Ore Zone (Figure 16)

This unit consists of a quartz-sericite schist with lapilli-sized siliceous fragments. On the west side of the outcrop, the rock contains molybdenite, pyrite, and green mica. A drillhole near this location assayed 0.1 ounce gold per ton across 20 feet (Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay). A feldspar porphyry sill cuts the north side of the outcrop.

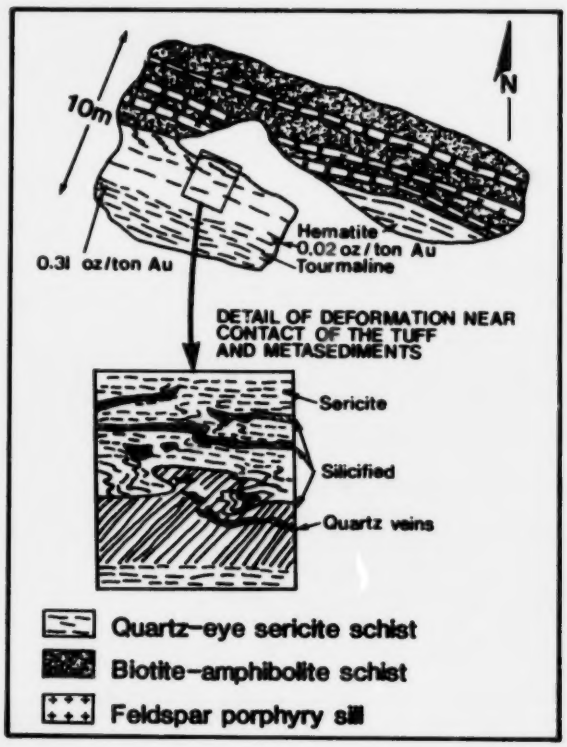


Figure 13. Lower, or Lake Superior South, Ore Zone—Stop 11B.

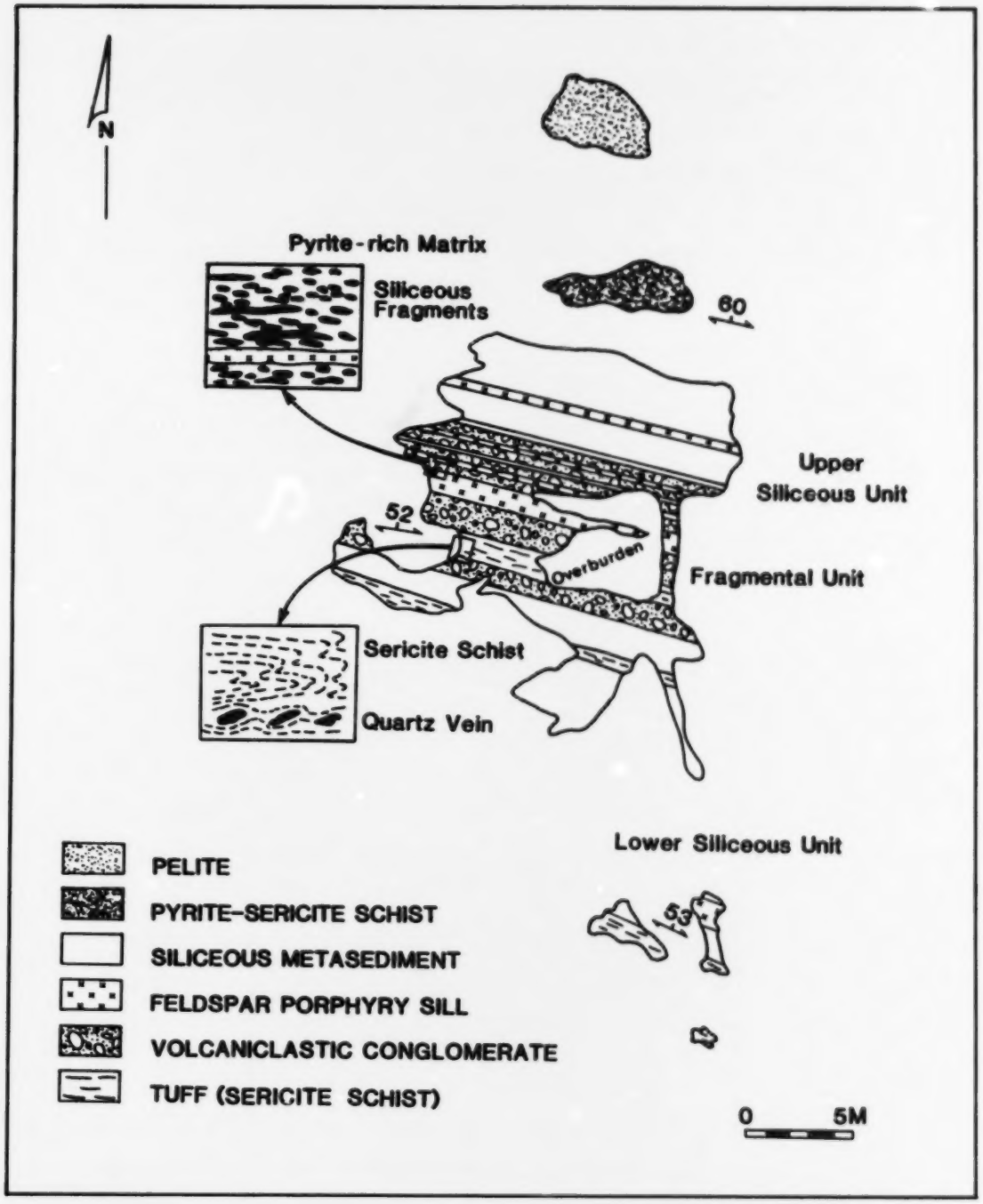


Figure 14. Lac Minerals Limited trench—Stop 11D.

Stop 11G.

Volcaniclastic Conglomerate

The northern end of the outcrop is a folded pelitic metasediment, containing staurolite and garnets. The southern end is a volcaniclastic conglomerate (it has also been suggested that it may be a mylonite). The volcaniclastic conglomerate consists of 10 to 20% indistinct and deformed green clasts, in a pink matrix containing 5% quartz-eyes, 10% feldspar crystals, and 85% fine siliceous material. In drill core this unit was found to contain a clast of molybdenite-rich siliceous ore, with visible gold (R. Quartermain, project geologist, Teck Corporation, personal communication 1983). The diabase dike which separates the Corona East and Corona West Ore Zones is exposed 10 m to the east.

Stop 11H.

The Barren Sulphide Zone (Figure 17)

The western part of this outcrop consists of quartz-eye tuff locally referred to as the "Barren Sulphide Zone". Disseminated pyrite and pyrrhotite occur for 5 m on either side of the contact with overlying metasediments. The conductive unit can be traced by VLF EM and serves as a stratigraphic marker horizon. In many places the tuff contains sericite and minor green mica. Deformation is most intense along the contact between tuff and metasediments; the state of strain can be observed in a boudinaged mafic dike. Within the Barren Sulphide Zone, bedding in the tuff is at an angle of 20 to 30° to the metamorphic foliation, and sulphides occur within the foliation plane. Grab samples returned assays of 0.51, 0.02, and (5 samples) <0.01 ounce gold per ton (Geoscience Laboratories, Ontario Geological Survey, Toronto).

The eastern part of the outcrop consists of folded and boudinaged, calc-silicates and pelites in metasiltstone (*see* Figure 17). The pelite contains garnet, staurolite, sillmanite, cordierite, and anthophyllite. The calc-silicates consist of calcium-rich amphibole, commonly on the margins of boudins and layers, and calcium-rich plagioclase.

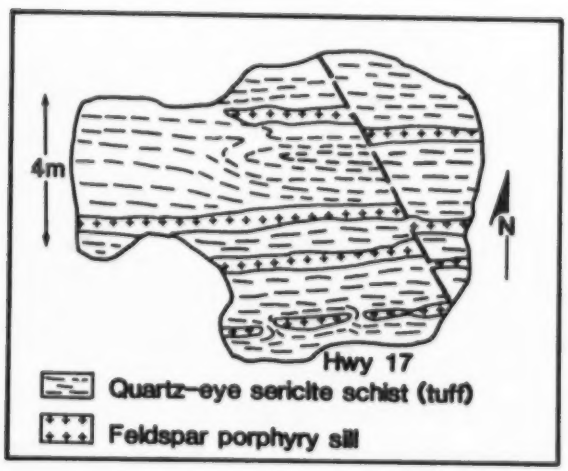


Figure 15. Footwall quartz-eye sericite schist—Stop 11E.

Stop 11I.

The Upper Volcaniclastic Unit

This unit consists of deformed clasts of quartz-feldspar porphyry with minor amounts of chlorite schist clasts. Bedding is defined by the percentage of clasts within the beds. Cut slabs show the clasts to be deformed by foliation 1:3 and lineated up to 1:10. Lineation is parallel to the axis of minor folds at a trend of 70°E.

Stop 11J.

Folded Metasiltstones

A unit of thickly bedded metasiltstones forms a gentle overturned synform plunging to the west. The fold is best observed on the south side of Highway 17. Note that the metasiltstones display both foliation and bedding. Foliation is consistent at 120/50N while the bedding defines the synformal fold. Rip-up clasts within the metasiltstone have been rotated into the foliation plane. A feldspar porphyry dike, which has been boudinaged, occurs at the nose of the fold, and a metmorphosed gabbro dike cuts the metasediments near the northeast end of the road-cut.

Stop 12

Contact Between Metasediments and the Cedar Lake Pluton

Just to the east of the Noranda Access Road the contact between the Cedar Lake Pluton and metasediments is exposed. Hornblende-biotite granodiorite dikes intrude the metasediments parallel to foliation as a series of dikes extending over a distance of 500 m. A quartz vein, 10 to 20 cm wide, containing molybdenite and pyrite, is located on the north side of the outcrop. Some of the joint surfaces in the metasediments are coated with fluorite. Joint surfaces in the granodiorite contain epidote and bluish chlorite.

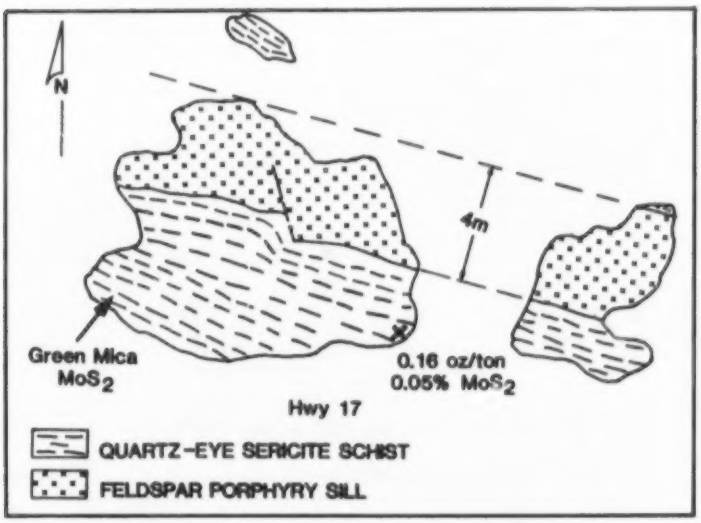


Figure 16. West Ore Zone of International Corona Resources Limited—Stop 11F.

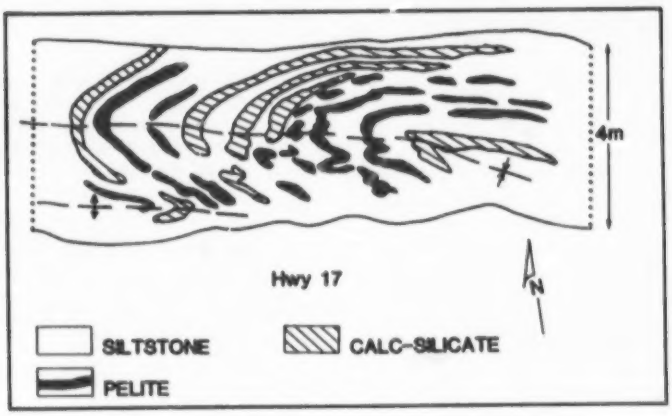


Figure 17. Pelitic calc-silicate metasediments—Stop 11H.

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